ANNALS

OF

The Entomological Society of America

VOLUME XXXIX, 1946

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CLARENCE H. KENNEDY, *Editor Emeritus*

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THE ENTOMOLOGICAL SOCIETY OF AMERICA

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ANNALS

OF

The Entomological Society of America

Volume XXXIX MARCH, 1946 No. 1

THE ENTOMOLOGICAL SOCIETY OF AMERICA

NEWS OF THE MOMENT

RESULT OF MAIL BALLOT TO MEMBERSHIP

The ballot was sent out to the membership of 955. 592 ballots were returned representing a vote of 62%. Both measures were carried by a large majority, as follows:

1. Nathan Banks was elected an Honorary Fellow of the Entomological Society of America by a vote of 589 to 3.

2. The annual dues of the Society were raised to $5.00 per annum and the non-membership subscription price raised to $6.00; with affirmative votes 472, negative votes 112, no vote on this question 8.

NEW MEMBERS

The following new members were recommended and nominated for membership in the Society from April 30 to October 6. They were elected to membership by mail ballot of the Executive Committee.

BALL, WILLIAM HOWARD, 1861 Ingleside Terrace, N. W., Washington 10, D. C. Asst. Ent., Div. of Control Investigation, Bureau of Entomology and Plant Quarantine.

BUCHANAN, WILLIAM DWIGHT, 522 Remington Street, Fort Collins, Colorado. U. S. Department of Agriculture.

FAURE, GABRIEL OLALQUIAGA, Dept. Sanidad Vegetal, Casilla 4637, Santiago, Chile, South America.

FONTAINE, RUSSELL EDGAR, 449 Mill Street, Worcester 2, Massachusetts. Asst. Ent., 1st Service Command Lab., Jamaica Plain, Mass.

GELFAND, CAPT. HENRY M., 41-13 162nd Street, Flushing, New York.

JOYCE, CHARLES RAYMOND, U. S. Public Health Service, Quarantine Station, P. O. Box 992, Brownsville, Texas.

OWSLEY, WILLIAM BURR, Kentucky Wesleyan College, Winchester, Kentucky. Prof. of Biology.

ROBINSON, JOHN H., P. O. Box 3391, Orlando, Florida. U. S. Department of Agriculture.

WEST, FENTON, 3401 Auburn Road, Huntington, West Virginia.

SOCIETY BUSINESS AND APPOINTMENTS

Fortieth Annual Meeting, 1945–6.—The Executive Committee, following the resolution of the business meeting in New York City, voted to hold the annual meetings (as of 1945) of the Society in conjunction with the AAAS in St. Louis, Missouri, March 27, 28 and 29, 1946. The North Central States Branch of the American Association of Economic Entomologists is holding their annual meeting at the same time and place.

Committee on Biographies.—In June, 1945, President Rehn appointed a Committee on Biographies, consisting of Harry B. Weiss, J. S. Wade, and E. O. Essig, Chairman. This committee will handle the preparation of obituaries and other biographical matters of the Society.

Secretaries Conference.—On October 21, 1945, the Secretary-Treasurer attended the Secretaries Conference of the AAAS and affiliated societies. A wide variety of topics regarding the annual meetings were discussed.

National Research Council.—Following the letter of protest sent to the National Research Council regarding their failure to include an entomologist in their "Committee on Insect Control," we are in receipt of a letter from Frank B. Jewett, President, National Academy of Sciences, advising us that when the committee was first formed, "the primary problems on which advice was needed were chemical and medical. As there was need for haste and as it was not clear just how entomology should be represented or by whom, only the nucleus of the Committee and various departmental liaison representatives were appointed.

"Since that time Dr. Roger B. Friend, State Entomologist of Connecticut, has been made a member of the Committee. While I do not have the list of liaison representatives available, it is my recollection that one of those from the Department of Agriculture is an entomologist.

"You and the Executive Committee of the Society may be assured that the field of entomology will be fully covered in the operations of the Committee and I would appreciate your sending each of them a copy of this letter."

Open Abstract Bulletin.—The Society received a request from the Coordination Center of the Insect Control Committee, National Research Council, for assistance in augmenting its mailing list of entomologists for the Committee's forthcoming "Open Abstract Bulletin" on insect and rodent control. A local committee consisting of C. W. Weinman, M. W. Sanderson and W. P. Hayes, Chairman, was appointed to obtain this information. The committee's report was forwarded without delay to Mr. B. Stockton, Office Manager of the Coordination Center.

The Open Abstract Bulletin will publish an accumulation of material relative to insect and rodent control. This material has been abstracted heretofore in secret and restricted bulletins and limited to a restricted circulation, which has now been declassified. It is the desire of the Coordination Center to send this Bulletin to entomologists and others who have a definite interest in insect or rodent control. If you wish

your name to be placed on the mailing list for this Bulletin, Mr. Stockton requests that you write to the Coordination Center, National Academy of Sciences, 2101 Constitution Avenue, N. W., Washington 25, D. C.

Education.—The Vocational Service Bureau submitted a request for information regarding colleges in North America offering courses in entomology and inquiring about the standing of each. This letter was referred to Dr. Roger C. Smith for reply. Dr. Smith brought up the matter which has come up before, namely, the inadequacy of the Society's information regarding the entire educational situation and the need for general information of this sort being readily available to persons who want it. It is suggested that this subject be brought up for discussion at the business meeting at the annual meetings in March.

CHANGE OF ADDRESS

In order to keep our files as nearly up to date as possible, will you please report to the Secretary any change of address? If you wish your Annals to be sent to one address and your other Society mail to a second, please state clearly how you want this done.

We will be publishing a membership list in the next issue and would appreciate your cooperation in making sure that this list is as up to date as possible. This applies especially to military personnel and members recently released from the armed services.

HERBERT H. ROSS,
Secretary-Treasurer.

OBITUARIES

DR. JOHN BARLOW, charter member of the Entomological Society of America, died suddenly in the Baptist Hospital at Brookline, Mass., on November 26, 1944, where he had gone two days previously for an operation. Doctor Barlow was born in Amenia, N. Y., November 28, 1872, and was the son of Henry and Helen Cynthia (Benton) Barlow. His early education was received in the schools of Hinsdale and Pittsfield, Mass., and from a private tutor. He was graduated from Middlebury College (Middlebury), Vt., in 1895 with the degree of B.S. From Brown University in 1896 he received his M.A., which university awarded him the honorary D.Sc. in 1932. In 1943, at the Fiftieth Commencement of Rhode Island State College, he was awarded a similar honorary degree.

In 1897 he worked for a brief period at the Rhode Island State College as an assistant in biology. From 1898 to 1902 he was Professor of Zoology at Fairmount College (now Wichita University), in Wichita, Kansas. He returned to the Rhode Island State College in 1902 as Professor of Zoology where he remained until his retirement in 1942. In addition to his teaching he was appointed dean of the State College School of Science and Business in 1925 and five years later was named dean of men. He also served as Vice-President in 1930, Acting President, 1930-1931, and again in 1940-1941.

Doctor Barlow also took part in the civic affairs of the community. He served six terms on the Rhode Island Bird Commission; for a time he was president of the South Kingston Town Council on which he served for five years; for many years he was treasurer of the Village Improvement Association of Kingston. And he also served on such faculty committees as student activities, tax, athletic and social. During the course of his teaching, he conducted special studies on spiders and the Corrodentia and developed the college's library of histological slides. In addition to his membership in the Entomological Society of America, he was a fellow of the A.A.A.S., a member of the Rhode Island Institute of Instruction, and several fraternities and lodges.

During his long association with the Rhode Island State College he was highly regarded, by the faculty, in the classroom and laboratory, during his various administrative offices and in his position as a friend and counselor to the students. He was buried November 29, 1944, in Old Fernwood Cemetery, West Kingston, R. I.—HARRY B. WEISS.

MISS EDITH WEBSTER MANK, who joined the Entomological Society of America in 1922 and who became a life member in 1931, died at her home, 12 Reservoir Street, Lawrence, Massachusetts, on July 17, 1945. Born in New Gloucester, Maine, September 20, 1892, her parents being the Rev. Herbert G. Mank and Georgianna Mank, Miss Mank, except for her childhood years, lived all her life in Lawrence, where she taught biology in the Lawrence High School. Graduating with honors from Mt. Holyoke College in 1913, Miss Mank took her Master's degree at Cornell in 1923, specializing in entomology. She early became interested in systematic work in the Coleoptera, and in addition to her teaching and collecting activities, described one new genus and eight new species. Her work on beetles received much friendly help and encouragement from the late Dr. H. C. Fall, and specimens for study, and suggestions resulted from her correspondence with such entomologists as the late Charles W. Leng, Ralph Hopping, J. B. Wallis, H. B. Leech, R. E. Snodgrass, P. J. Darlington, Jr., G. Chagnon, N. M. Comeau, C. A. Frost, Henry Dietrich, and others.

Within recent years, Miss Mank had specialized on the Melandryidae and was reviewing this family, giving special attention to the male genitalia, when her final illness occurred. Always an enthusiastic and popular teacher, Miss Mank had the satisfaction of seeing many of her former students follow biology as their life work.

In addition to her membership in this Society, Miss Mank was a member of Phi Beta Kappa and of the American Association for the Advancement of Science. Her collection of 5,500 species of North American Coleoptera involving over 17,000 specimens and 3,800 exotic species involving over 4,000 specimens was willed to Cornell University and is now at the University Museum. Miss Mank was the author of the following papers:

1934. New Species of Orobanus. Pan-Pacific Ent., 10 (3): 121-124.
1937. A Note on Two Species of American Xylitas. Can. Ent., 69: 18-19.
1938. A Revision of the Genus Zilora. Psyche, 45 (2-3): 101-104.
1939. Scotochroa and a Closely Allied New Genus, Scotochroides (Coleoptera, Melandryidae). Can. Ent., 71: 181-183.
1939. A Review of the Genus Serropalpus, (Coleoptera, Melandryidae). Can. Ent., 71: 237-239.
1940. A New Species of Haliplus. Psyche, 47 (2-3): 57-59.
1942. A Review of the Genus Anelpistus Horn (Coleoptera, Melandryidae). 74: 186-193.

—H. B. WEISS.

DR. JOHN DINWIDDIE MAPLE, Lieutenant Senior Grade, U. S. Naval Reserve, was killed April 11th in an airplane crash on the beaches of Okinawa, reportedly while supervising the application of DDT to the terrain ahead of assault troops.

Prior to accepting a commission in the Navy, Dr. Maple was stationed at Orlando, Florida, where he was in charge of the laboratory testing of anopheline larvicides for the United States Bureau of Entomology and Plant Quarantine. In this capacity he was one of the first to test DDT for mosquito control.

After several months on Guadalcanal and other South Pacific islands, he was sent to Honolulu to assist in the organization and coordination of malarial control in the various services. Dr. Maple's primary interest, however, was in insect biology. His thesis submitted in 1934 for the degree of Master of Science at the University of California was entitled "Biology of the genus *Leucopis* (Diptera)." In 1940 he received the degree of Doctor of Philosophy at the University of California, submitting a dissertation entitled "The Eggs and First Instar Larvae of Encyrtidae and their Morphological Adaptations for Respiration." Both theses are exemplary.

While gathering material for his Doctor's thesis, Dr. Maple collected a number of new species of mealybugs and perfected a method for preparing them for slide mounts which Professor G. F. Ferris considered to be unsurpassed.

In 1938 Dr. Maple was employed by the Department of Entomology and Plant Quarantine to study the biology of insect parasites in the Orient with the view

to their ultimate utilization in the United States. During December, 1941, he was interned by the Japanese Government. In June, 1942, he was repatriated in an exchange of prisoners.

Dr. Maple was born at Whittier, California, in 1910, and graduated from Pomona College in 1932. He was a member of Alpha Sigma Phi and Sigma Xi, Entomological Society of America, and the American Association for the Advancement of Science.

He is survived by his parents, Mr. and Mrs. Amos C. Maple; a grandmother, Mrs. J. H. Newlin; and four sisters, Mrs. Bewley Allen of Whittier, Miss Margaret Maple of Claremont, Mrs. Mason Hill of Bakersfield, and Mrs. Edward H. Kroeger of Whittier.

The Entomological Society of America is honored in having had as a member a scientist of such high purpose and integrity. Dr. Maple was a militant idealist and an exponent of accuracy and thoroughness, and yet he possessed a lovable and charming personality. His attitude toward the war was influenced by his Quaker forebears. His military life, however, was so personally beneficial that he could write to his parents that he was giving "service without sacrifice."

Dr. Maple was posthumously awarded the Bronze Star Medal through his parents, Mr. and Mrs. A. C. Maple. The citation accompanying this medal is for outstanding professional ability and sound judgment in the fulfillment of duty.

—S. E. Flanders.

Ralph Henry Smith was born on a farm at Kincaid, Anderson County, Kansas, June 7, 1888. He died at his home, 1634 Greenfield Avenue, Los Angeles, California, early Saturday morning, September 22, 1945. His parents were pioneer farmers and he lived the usual rigorous life common to his times on the mid-western farm. He attended the country schools in Kincaid and spent two years at the Garnett High School, after which he took the county examination for teachers, which he passed, and taught two terms in a country school before he was twenty years old. In 1908 he entered Kansas State Teachers' College at Emporia, where he graduated in 1914. He taught for one year in the high school at Blue Rapids, Kansas, and was Superintendent of Schools in Irving, Kansas, for the next two years. In 1915 he entered the University of Kansas and received the A.B. degree in the spring of 1916. In July of that year he received a teaching fellowship at the Oregon State College at Corvallis. In 1917 he entered the University of California at Berkeley where he was a teaching fellow in Zoology and received his M.A. degree there in May, 1918. He was immediately sent by the Federal Government to take charge of a war emergency project on the control of clover aphis at Twin Falls, Idaho. At the end of the war, the Idaho Agricultural Experiment Station took over the work and established a sub-station at Twin Falls with Mr. Smith in charge. In 1922 he went to San Francisco and, while working as research entomologist for the California Central Creameries, developed the casein spreader now so widely used in sprays. During the two years he worked on that project he continued the codling moth investigation and visited practically every state and all the important apple growing districts in the United States. In the fall of 1924 he reentered the University of California at Berkeley, completing the work on his Ph.D. in the spring of 1925.

He then accepted a position as Acting Assistant Professor in the Entomology Department at Stanford University during the fall and winter term of 1925–26. In March of 1926 he received an appointment as Assistant Entomologist in the University of California Citrus Experiment Station at Riverside and began work on oil sprays. During the ten years he spent at Riverside he developed and perfected the tank mix oil spray, which has been used the world over. He was promoted to Associate Entomologist in 1927 and to Entomologist in 1931. He was also given the additional title of Lecturer in Entomology and Entomologist in the Experiment Station when transferred to the University of California at Los Angeles in 1936 where he was in charge of the entomological work on that Campus which was under the general supervision of Prof. H. J. Quayle and subsequently Dr. A. M. Boyce of the Division of Entomology, Citrus Experiment Station at Riverside. In 1937 he was advanced to Professor of Entomology. While at Riverside, he served on the City Board of Education and was particularly active in the development of better school facilities in that city.

Since that time he has investigated the insects affecting ornamental plants and devised means for their control.

During the past few years he made outstanding contributions in studies of the life history and control of the sycamore scale, *Stomacoccus plantani* Ferris and the nigra scale, *Saissetia nigra* (Nietner). His surveys of the insects attacking flowering and greenhouse plants were very thoroughly and carefully made and his notes are of great value. He was also very much interested in plant-infesting mites and made extensive collections of these pests throughout the West.

In January, 1933, he was invited by the Citrus Growers of Texas to visit the Lower Rio Grande Valley and to advise them concerning especially the use of oil sprays for controlling red scale in that region.

At the time of his death he was conducting extensive experiments on the uses of the new insecticide, DDT, in the control of insect pests of ornamental plants. He was also preparing manuscripts for two books: one "The Insect Pests of Ornamental Plants in the United States" and the other, "The History of Oil Sprays."

Dr. Smith published very many articles in journals, bulletins, circulars, and agricultural papers, all of which have constituted worthy contributions to science. In 1914, at Bonne Terre, Missouri, he was married to Sarah Fake, a fellow school teacher of Irving, Kansas, who survives him, along with four sons: Norman, Hamilton, Gordon, and Stanford. His mother, two brothers, and three sisters, all of whom live in Kansas and Oklahoma, also survive him.

Although he was never a very strong man, yet his ambitions and determination drove him to great heights of endeavor and he accomplished unbelievable results in many walks of life. His splendid character, high ideals, absolute honesty, and friendliness made him a man of great worth in his home life, in society, and in his profession.—E. O. Essig.

We regret to report also that the Society has lost by death three other members, Peter C. Grassman, William T. Davis, and Theodore H. Frison. Obituary notices of these are in process of preparation.

The Committee on Biographies.
H. B. Weiss,
J. S. Wade,
E. O. Essig, *Chairman.*

PREDOCTORAL FELLOWSHIPS IN THE NATURAL SCIENCES

The National Research Council announces that it is now ready to receive nominations and applications for the predoctoral fellowships in the natural (i. e., mathematical, physical, and biological) sciences which it is administering under a grant from the Rockefeller Foundation. These fellowships are intended to assist young men and women, whose graduate study has been prevented or interrupted by the war, to complete their work for the doctorate. It is hoped that these fellowships will do much to accelerate the recovery of the scientific vigor and competence of the country which is so seriously threatened by the loss of almost two graduate school generations of scientifically trained men and women.

The annual stipend will be $1200 for single persons and $1800 for married men. In general it is expected that each recipient will spend at least eleven months per year on academic work. An additional allowance up to $500 per year will be made for tuition and fees. Fellowships granted to individuals who are eligible for educational support from the "G. I. Bill of Rights" will be at such stipends as to bring the total income from these two sources to that which would be received at the above rates.

Prospective candidates for these fellowships are urged to apply at once even though they may be unable to undertake their graduate study in the immediate future. Information concerning these fellowships and Nomination-Application blanks are being mailed out widely to graduate schools and wartime research laboratories. They may also be obtained by writing directly to the Secretary, Committee on Predoctoral Fellowships, National Research Council, 2101 Constitution Avenue N. W., Washington 25, D. C.

DIMORPHISM IN THE AFRICAN OECOPHYLLA WORKER AND AN ANOMALY (HYM.: FORMICIDAE)

NEAL A. WEBER
University of North Dakota
Grand Forks, North Dakota

The genus *Oecophylla* comprises the species of ants whose larvae produce silk and are used by the workers as shuttles in weaving their nests (fig. 1). Two species are recognized, *longinoda* (Latreille) of the Ethiopian Region and *smaragdina* (Fabricius) of the Indomalayan and Papuan Regions. Each has several described varieties and subspecies. The worker is formally characterized as slightly polymorphic.

While examining workers of a nest which I had collected in the Anglo-Egyptian Sudan I was impressed by their variation in size and had measured one hundred workers taken at random from each of three colonies (figs. 7–8). Two measurements were made of each, the total length, which is difficult to make precisely because of the variability in extension of the gastric segments, etc., and the thoracic length. Inasmuch as the coefficient of correlation between the body length and the thorax length was +.90, only the body length was used for the graphs since graphs of thorax lengths were essentially duplicates.

The results of the measurements indicated a surprising dimorphism which has gone completely unrecognized and suggest that other ants which are "polymorphic" may prove to fall into several castes when examined statistically. The physiologic implications are significant. When the extremes of workers are obvious, as in the maxima and minima *Atta*, the rôle of each is similarly obvious. Perhaps there is a similar division of labor in *Oecophylla*, the smaller workers caring for the brood, the larger workers holding leaves together in nest making, defending the nest, etc.

The African species nests in trees and is polydomous. A tree with a large colony may be completely dominated by the ants, which are aggressive and swarm over an intruder, biting viciously. The African species and its forms were described and the literature summarized by Wheeler (1922). While known from numerous localities in tropical Africa, there were no records from the Anglo-Egyptian Sudan in this study or in later papers on the African fauna. Sudan records were briefly summarized recently (Weber, 1943) and, with other unpublished records, are given below:

At Kagelu, Equatoria, A.-E. Sudan, the late Dr. J. G. Myers took them March, 1939 (Nos. 10593, 10601, 10628) and I took them July 17 and August 12, 1939. I found them in gallery forest running on vines at four feet above the ground, tending coccids on leaves, and nesting at a height of six feet. Two leaves of a vine were closed with silk and on the upper surface of one leaf the ants were tending coccids. The ant brood was inside the leaves.

At Torit, Equatoria, A.-E. Sudan I found them nesting abundantly on mango trees July 21 and August 6, 1939. They were examined on

the later date. One mango, then in flower, had scattered nests over the entire crown and the ants clearly dominated the tree. Their bite was perceptible and their swarming aggressiveness made investigation difficult. In one nest an alate female, pieces of a bee, a grasshopper, a dipteran, ponerine ants and a larval myrmecophile were found. In addition to the anomaly described below there were 505 workers (305 maxima, 200 minima) and 70 larvae.

Another mango was the next in a row of trees and was 92 feet away. It was also controlled by the ants. Several nests at a height of seven feet were removed but contained only workers. 218 workers were collected (167 maxima, 51 minima). It appeared that when these nests naturally age, dry, and wither the ants abandon them. They then move to adjacent green leaves and make nests but when the sites on an entire branch are exhausted the colony moves away. As they appear to start from the proximal portion of a branch and move distally they eventually find themselves out on a barren limb. Evidence for this was the fact that proximal nests were abandoned, distal ones still green. A fresh green nest contained a number of males, an adult fly and a dipterous larva 12 mm. x 3.5 mm. when freshly chloroformed. There were no remains of food and no brood. Another nest from the same mango contained alate females, 50 larvae, 556 workers (298 maxima, 258 minima) and parts of a medium-sized beetle.

In life the workers would run to the typical *longinoda* in Wheeler's key (1922). The mandibles were of the same ferruginous color as the head, thorax and pedicel. The gaster, however, was distinctly a paler ferruginous. After being chloroformed for three hours the gaster became darker than the rest of the body and became distinctly ringed, the distal portion of each segment being paler than the remainder. After six years the dried workers are largely pale ferruginous and concolorous with the dorsal surface of the trunk slightly darker than the remainder of the body. The color is essentially like that of Accra, Gold Coast and Mafia I., Tanganyika specimens. According to the

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EXPLANATION OF PLATE I

FIG. 1. Nest of *Oecophylla longinoda* of mango leaves. Leaves fastened together with silk fibers from the ant larvae. Single entrance below. Torit, Equatoria, Anglo-Egyptian Sudan (N. A. W.).

FIG. 2. Dorsal view of maxima worker showing normal thorax and petiole. Body length 8.0 mm., thorax 2.35 mm. From colony in mango tree, Torit, Sudan.

FIG. 3. Dorsal view of anomalous maxima worker from same colony as worker in Fig. 2 showing petiole fused to thorax and compression of segments. Thorax with petiole 2.99 mm.

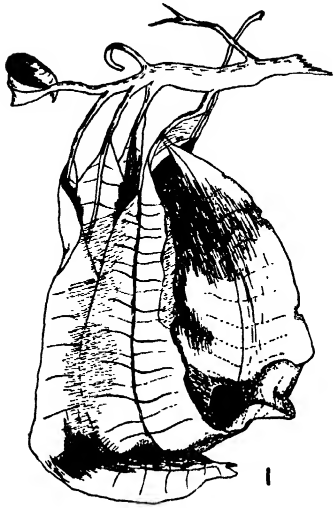
FIG. 4. Lateral view of maxima worker of Fig. 2 showing manner of measuring thorax length by arrows and habitus of normal thorax and petiole.

FIG. 5. Lateral view of anomalous maxima worker of Fig. 3.

FIG. 6. Lateral view of minima worker from colony of Figs. 2–5. Body length 4.5 mm., thorax 1.25 mm.

FIG. 7. Graph showing frequency distribution of body lengths of 100 ants from each of three colonies from mango trees at Torit, Sudan, including the colony from which came the ants of Figs. 2–6.

FIG. 8. Graph showing frequency distribution of the body lengths of the 300 ants from the three colonies of Fig. 7.



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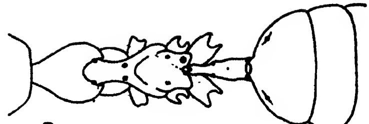

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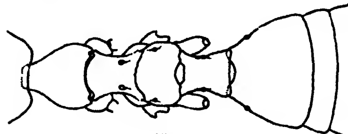

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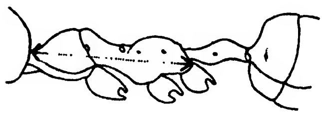

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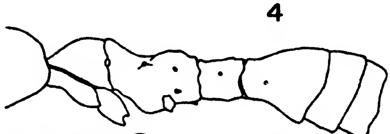

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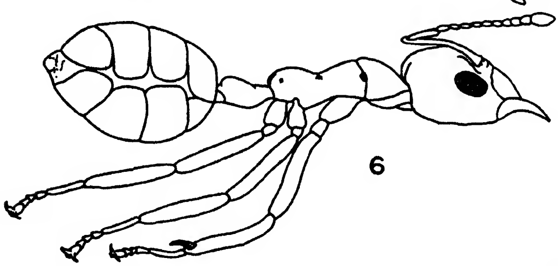

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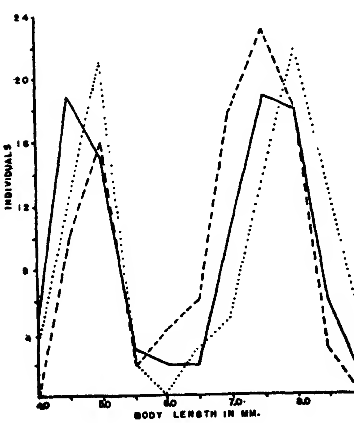
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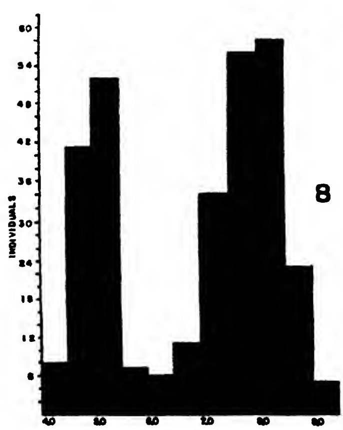
BODY LENGTH IN MM.

7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48
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6
INDIVIDUALS
4.0
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9.0
BODY LENGTH IN MM.

8

key the typical form is found in West Africa while a new variety, ***annectens***, was created for the darker workers from Belgian Congo localities close to my Sudan places. As the color may differ slightly according to preservation conditions, varieties based upon this character may not always be valid. There do, however, appear to be much darker forms (*rubriceps* Forel and *fusca* Emery), black or nearly black, which are found in West Africa.

Mr. D. Vesey-Fitzgerald sent me workers, supposedly belonging to the variety *textor* Santschi, from Tchole I., collected in July, 1936, and from Mafia I., both off the coast of Tanganyika. He reported it abundant on Mafia, making nests in trees, consisting of leaves spun together with silk, and to be a common attendant of coccids. In Zanzibar he stated it to be a menace, biting viciously and interfering with the clove pickers when they climb the trees.

So many of the Sudan ants were measured as to modify somewhat and make more complete the published sizes for the sexes, and in addition to make possible a characterization of worker maxima and minima castes for the first time. They may be summarized as follows:

Female.—Total length 15.5 mm. (14.5–16.5 mm.); thorax 5.3 mm. (5.0–5.5 mm.); anterior wing 15.0 mm.

Male.—Total length 6.5 mm. (6.0–7.0 mm.); thorax 2.76 mm. (2.64–2.79 mm.); anterior wing 6.8 mm.

Maxima worker.—(figs. 2, 4). Total length 6.5–9.4 mm. (average 7.8 mm.) thorax 2.2–3.1 mm. (average 2.6 mm.). Head convex behind, antennal scapes clavate distally and much more elongate than in minima, funicular segments 1–4 and terminal segment also more elongate; thorax more slender and anteriorly less convex than in minima, meso-epinotal impression deeper and longer than in minima, epinotum more convex than in minima; petiole more elongate and with less marked node than in minima.

Minima worker.—(fig. 6). Total length 4.0–6.4 mm. (average 4.8 mm.), thorax 1.24–2.1 mm. (average 1.5 mm.). Head less convex behind and body generally more compressed than in maxima. The petiole is dorsally grooved by a longitudinal furrow as in the maxima but this is so much deeper as to make the node bituberculate above.

The anomaly figured (figs. 3, 5) came from one of the Torit, Sudan nests. It is a worker whose petiole was telescoped into the epinotum, both being anterior abdominal segments primitively. This condition, of course, must have arisen in the pupal or an earlier stage. Since it had attained full adult coloration the ant had been able to live in this condition. I have a similar anomaly in a worker of ***Myrmica brevinodis*** Emery from Montana.

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THE NESTS AND THE ADULTS OF COLONIES OF POLISTES WASPS

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POLISTES PALLIPES AND POLISTES VARIATUS: A COMPARATIVE STUDY OF NEST SIZE

The variation in the size of the nests of each species of *Polistes* wasps may be attributed to several factors. Among them is an early or late start in the spring by a foundress queen, the founding of the nest by one or by several queens who work cooperatively, the conditions of weather, such as amounts of sunshine or gloom, wetness or dryness, cold or warmth, the abundance of nectar-bearing flowers, as well as the abundance of caterpillar meat. But above all the size of the nest is influenced to a great extent by the temperament of the foundresses, who may be brilliant or stupid, lazy or industrious.

In observing the nests of the two species, both occupying the same habitat, I have long suspected that those of *variatus* are generally larger in size than those of *pallipes*. I suggested, therefore, that the nest size should be considered (among other items) a valid character in puzzling out the taxonomic status of the difficult genus *Polistes*.[1] Since colonies of *pallipes* and *variatus* are founded by a single queen and are contemporaneous in this locality, it is quite likely that differences which we may find in nest size can be attributed to the specific temperaments of the foundresses of each species.

By collecting the nests of both species from one or another locality in Missouri close together in periods of time, I have been able to study the cells in the nests, and tabulate the result.

The table shows the progressive growth of the nests for both species throughout the summer, and by glancing at it, one may get a picture of the industry of both species from time to time.

The table shows for both species the time when, and the place where the nests were collected, the number of nests taken, the number of cells in the nests, and finally the average number of cells. There is no relationship, however, between this count and the nest population, for in the nests all cells were counted, even those that did not, or probably could not, because of the lateness of the season, give forth adults, and the number of cells that were used more than once for brood were not considered at all. The figures are merely an index of the industry of the colony in nest construction.

By comparing the two columns of averages in the table, one may quickly see how progressively the nests of *variatus* are always a little larger than those of *pallipes*. *Variatus* throughout the season always keeps a little ahead of *pallipes*. Both species commence their colonies at about the same time in the spring, under identical conditions of weather, shelter and food, but evidently the *variatus* queen works

[1]See my paper, "The Nesting Habits of Polistes Wasps as a Factor in Taxonomy." Ann. Ent. Soc. Amer. 35: 335–338, 1942.

harder or faster than *pallipes*, brings her first brood of helpers to maturity a little earlier, gains in the race throughout the summer, and finally toward the end of the season (compare the last three entries in the table for *pallipes* with the last two for *variatus*), is ahead of *pallipes* by an average of over 50 cells per nest.

The nests of *pallipes* and *variatus* are never so large as those of *annularis* and *rubigenosis* found hereabouts, but the latter two are usually founded co-operatively by several queens. The largest nest of

Pallipes					Variatus				
Date	Location, Missouri	No. Nests Studied	No. Cells in Each Nest	Average No. of Cells	Date	Location, Missouri	No. Nests Studied	No. Cells in Each Nest	Average No. of Cells
4/11/39	Kirkwood..	6	1–3	2	4/11/39	Kirkwood.	1	6	6
5/ 1/40	Pacific.....	4	1–6	3.2					
5/10/40	Arcadia....	4	10–23	14.2					
5/20/39	Vigus......	7	11-18	14.4	5/20/39	Vigus......	3	20–23	21
5/30/39	Bourbon....	7	10–20	16.4	5/30/39	Bourbon....	3	15–26	20
6/ 9/40	Ranken....	14	12–24	15.6					
6/25/39	Ranken....	9	19–39	30.2	6/25/39	Robertsville	7	14–55	31
7/ 2/39	Byrnesville	10	17–50	29.5					
7/ 9/39	Wentzville.	11	22–57	35	7/ 9/39	Wentzville.	7	16–92	40 3
7/25/39	Ranken.....	3	72–123	83.3	7/25/39	Wentzville.	4	90–157	141
8/ 5/39	Rosetti.....	10	52–133	70.4	8/ 5/39	Rosetti.....	16	80-158	120
8/10/39	Crocker....	17	39–111	71					
Total no. of nests..102					Total no. of nests..41				

pallipes recorded in the table had 133 cells, and that of *variatus* had 158. Toward the end of the season of 1940 I made a special effort to find large nests of *pallipes*. I found only three that contained more cells than those listed in the table, and these had 135, 179, and 223 cells respectively. This is an indication of how large *pallipes* nests may get in this locality.

To conclude then, it seems that the nest size of these two species of *Polistes* wasps should be regarded to some extent as due to differences

in temperament of the two species since the conditions under which they live and labor are essentially the same.

All of the more or less intangible items of behavior, such as the one described in the preceding paragraphs, should, I think, be recognized by taxonomists, along with the more patent characteristics, when considering the problems of classification in *Polistes*. These wasps are difficult for the student of taxonomy, and this suggestion may only add to his worries. I, for my part, however, am only too happy to meet and greet *pallipes* and *variatus* as two distinct species, but, after all, I am not a taxonomist.

THE SEQUENCE OF THE SEXES IN POLISTES COLONIES, WITH REMARKS ON THE CONTROL OF SEX

The queens of certain social Hymenoptera, as is well known, have the power to lay fertile or infertile eggs; the fertile eggs eventually developing into workers or neuters, and the infertile ones into males. This is the notion that biology students have had of the process for a long time, but recently Verlaine (Biol. Abstracts 6: 620, 1932) has taken exception to this attitude. He is of the opinion that in bees, bumblebees, wasps and ants, the queens deposit only fertile eggs, and the workers deposit only infertile eggs. Verlaine apparently supplies experimental data in support of his views, but in regard to *Polistes* he is somewhat vague. I thought possibly a study of the sequence of emergence and the dates when the males first appear would give us some clew at least, to whether or not foundress queens are able to deposit both kinds of eggs.

Nests of *Polistes pallipes* and *P. variatus*, with immature wasps, were taken at various places in Missouri, brought into the laboratory, placed separately in cages, and a record kept of the sex of the first emerging adults.

Polistes pallipes

In Table I we have the emergence of the first *pallipes* from seven nests, taken at Bourbon, Missouri.

TABLE I

Nest No.	No. of Adults on Nest	1st Workers Emerged		1st Males Emerged	
		Date	No.	Date	No.
		June			
1	1 queen..........	16 to 26	10		0
2	1 "	11 to 16	8		0
3	1 "	11 to 16	8		0
4	1 "	17 to 20	3		0
5	1 "	17 to 20	3		0
6	1 "	16 to 20	4		0
7	1 "	12 to 20	4		0
Total	....	....	40		0

The seven nests, taken May 30, 1939, gave forth the first brood of adults, 40 in number, between June 11 and June 26; all of which proved to be workers. There was not a male among them, and it is quite evident that the first forty eggs deposited by the seven founding queens were all, as one would expect, fertile eggs. There was only one adult on each nest when it was taken and it was the foundress queen.

Table II is on a collection of 14 *pallipes* nests taken at Robertsville, Missouri, about 27 days later.

TABLE II

Nest No.	No. of Adults on Nest		No. of Workers that Emerged in Laboratory		No. of Males that Emerged in Laboratory	
	♀	♂	Date	No.	Date	No.
8	3	0	6/28 to 6/29	3		0
9	....	....	7/5	1	7/5 and 15	2
10	3	0	6/28 to 6/30	3		0
11	6	0	6/27 to 7/9	8		0
12	5	0	6/28 to 7/8	8		0
13	4	0	6/26 to 7/9	5		0
14	3	0	6/27 to 6/29	3		0
15	2	0	6/26 to 7/13	12		0
16	5	0	6/26 to 6/28	2		0
17	4	0	....	......		......
18	2	0	6/26 to 6/29	4		0
19	4	0	6/26 to 6/28	5		0
20	4	0	6/26 to 7/9	8		0
21	7	0	6/28 to 7/9	5		0
Total	52	0		67		2

When the nests were taken June 25, several adults were on each nest. These were evidently members of the first brood, and consisted entirely of workers except for the one queen (which, incidentally, was indistinguishable from the workers) on each nest. There was not a male among the 52 wasps on these 14 nests.

In the laboratory, from these 14 nests there emerged 69 wasps between June 26 and July 15, of which 67 were workers and 2 were males.

We have for a long time known that foundress queens deposit fertile worker-producing eggs, and we thought we have also known that they are capable of laying parthenogenetic male-producing eggs later in the season. Since Verlaine says that the queen is incapable of depositing infertile eggs, our job is to discover if this is true of our local *Polistes*. Therefore, the dates July 5 and July 15, when the very first two males appeared in one colony, is indeed important. Were these two males the offspring of the foundress herself or of the workers? The males appeared in point of time so near the border line, that one will need to do some close figuring to ascertain if they are the progeny of one or the other.

To begin our calculations, we will have to fix the earliest day for the founding of the colonies. This is about the middle of April (Bull. Brook Ent. Soc. 33:232, 1938), and in the spring it requires about 45 days from the deposition of the eggs to the emergence of the adult. Therefore, at least one of the two males could not possibly be the product of the first brood of workers, but must have been deposited by the queen. The workers, whom Verlaine thinks are solely responsible for the males, could not have come upon the scene before 45 days from the middle of April, which is about June 1. Taking for granted the possibility that the workers deposited these infertile eggs, and assuming that as the season advanced the period of development was shortened to say, 40 days, the males could not possibly have become adult before July 10 to 15. Therefore, we must assume that at least one of the two eggs (and quite possibly both) which developed into males, was deposited by the foundress queen. Nowhere else do we find males appearing (see Tables III and IV) before July 15, and it is quite possible that all males appearing on or before July 15 are the product of the queens.

Analogous evidence substantiates this deduction, for Plath (Biol. Bull. 45:325–332, 1923) found that in a bumblebee nest, ***Bombus bimaculatus***, the first adult to develop from eggs deposited by the queen was a male, and the eleven which followed were also males. He thinks that the queen evidently had not been fertilized during the preceding autumn, for in another queen of the same species at the same time the first brood were all workers.

Taple III is the same data for 9 nests of ***pallipes*** gathered at Byrnesville, Missouri, at a still later date, July 2, 1939.

TABLE III

Nest No.	No. of Adults on Nest		No. of Workers to Emerge in Laboratory		No. of Males to Emerge in Laboratory	
	♀	♂	Date	No.	Date	No.
22	A count in this lot was omitted.		7/9	1		0
23			7/5	1		0
24			7/9	1		0
25			7/5	1		0
26			7/5to 7/7	2		0
27			7/4 to 7/9	3		0
28			7/4 to 7/6	2		0
29			7/4 to 7/22	6		0
30			7/6 to 7/18	6		0
Total				23		

Here 23 wasps emerged from 9 nests between July 4 and July 22, and not a male was among them.

Table IV is the same data for 17 nests of ***pallipes*** taken at Wentzville, Missouri, a week later—July 9, 1939.

TABLE IV

Nest No.	No of Adults on Nest		No. of Workers to Emerge in Laboratory		No. of Males to Emerge in Laboratory	
	♀	♂	Date	No.	Date	No.
31	6	0	7/23	1		0
32	6	0	7/15 to 7/19	3		0
33	6	0	....	....		....
34	3	0	7/15 to 7/18	3		0
35	2	0	7/13 to 7/16	3		0
36	3	0	7/15 to 7/18	5	7/22 to 7/27	5
37	2	0	7/18 to 7/20	4		0
38	3	0	7/18 to 7/23	3	7/23	1
39	2	0	....	0	7/15	1
40	6	0	7/12 to 7/18	8	7/15 to 7/19	5
41	5	0	7/10 to 7/18	5		0
42	3	0	7/18 to 7/24	7		0
43	....	....	7/22	2		0
44	5	0	7/19 to 7/22	2		0
45	3	0	7/20 to 7/22	4		0
46	4	0	7/15 to 7/23	12	7/20 to 7/26	5
47	....	....	7/19 to 7/23	6	7/20 to 7/25	8
Total	59	0		68		25

Here we note again that no males were found on the 17 nests when they were taken on July 9, but the workers on the nests numbered 59. In this table, however, the males are beginning to appear, for in the laboratory there emerged from the nests 68 workers and 25 males. No male, however, appeared before July 15 and it is still quite probable that these first males are the progeny of foundress queens, rather than of the workers.

Table V gives us similar data on a collection of 11 ***pallipes*** nests taken at Rosetti, Missouri, at still a more advanced date, July 28, 1939.

TABLE V

Nest No.	No. of Adults on Nest		No. of Workers to Emerge in Laboratory		No. of Males to Emerge in Laboratory	
	♀	♂	Date	No.	Date	No.
48	5	2	8/30 to 9/2	2	7/28 to 9/2	7
49	5	0	7/29	1	7/29	1
50	7	3	7/28 to 7/30	5	....	0
51	8	4	....	0	7/28 to 8/10	5
52	'8	20	....	....	....	....
53	13	4	....	0	8/5 to 8/8	3
54	9	16	....	0	8/5 to 8/20	5
55	6	2	8/5 to 8/12	2	8/10 to 8/20	3
56	....	....	8/7 to 8/13	4	8/4 to 8/8	3
57	....	....	8/4 to 8/12	10	8/6 to 8/16	4
58	....	....	....	0	8/10 to 8/13	2
Total	61	51		24		33

Here, on July 28, (see table), I found males in the colonies for the first time that year, and they were almost equal in number to the workers (61 workers and 51 males). In the lot that emerged from the nests in the laboratory, the males also predominated (24 workers and 33 males). The males emerged from the cells between July 28 and August 20, and the large number of males on the nests at that time, plus those which hatched in the laboratory, would of course indicate, but not prove, that the workers had had a generous hand in male production, since it is not likely that foundresses would possess such fecundity. But to know the proportion of males produced by both the queens and the neuters, one would need to dissect and study the ovaries of both at various periods during the summer. This would, of course, tell us something about the fecundity of the neuters and queens, and give us a clew to which caste which is responsible, and to what extent, for the male population.

Table VI is similar data on a collection of 31 *pallipes* nests taken at Crocker, Missouri, at the end of the season, August 10, 1939.

TABLE VI

Nest No.	No. of Adults on Nest		No. of Workers to Emerge in Laboratory		No. of Males to Emerge in Laboratory	
	♀	♂	Date	No.	Date	No.
59	....	....	....	0	8/13 to 8/20	7
60	....	....	....	0	8/15 to 8/21	6
61	0	8	....	0	8/13 to 8/25	10
62	....	....	....	0	8/13 to 8/20	14
63	....	....	....	0	8/11 to 8/20	4
64	....	....	8/13	1	8/11 to 8/13	6
65	....	....	....	0	8/13	2
66	....	....	8/17	1	8/17 to 8/23	8
67	5	0	8/13 to 8/26	5	8/13 to 8/20	14
68	2	4	....	0	8/14 to 8/17	6
69	8	18	....	....	....	....
70	8	10	....	0	8/14 to 8/20	11
71	5	0	....	0	8/17 to 8/21	9
72	5	6	8/14	2	8/14 to 8/16	6
73	14	17	....	0	8/13 to 8/15	4
74	1	14	....	0	8/20 to 8/23	4
75	1	4	....	0	8/21	4
76	8	9	8/13	3	8/13 to 8/17	9
77	4	13	8/14	2	8/13 to 8/14	2
78	5	16	8/13 to 8/20	2	8/13 to 8/30	17
79	3	9	....	0	8/13 to 8/15	5
80	6	2	....	0	8/20	1
81	4	0	....	0	8/14 to 8/23	9
82	12	0	8/14 to 8/20	2	8/14 to 8/21	5
83	0	4	....	0	8/14 to 8/20	5
84	16	7	....	0	8/13 to 8/20	10
85	1	2	....	0	8/14 to 8/26	5
86	....	....	8/14 to 8/20	5	8/11 to 8/17	7
87	....	....	8/11 to 8/20	5	8/11 to 8/20	10
88	....	....	8/13 to 8/20	3	8/13 to 8/21	8
89	....	....	8/14 to 8/17	3	8/11 to 8/17	9
Total	108	143		34		217

Early August seems to be a time for the preponderance of males. In taking the 31 nests, I found that the adults upon them numbered 108 workers and 143 males. There was also a preponderance of males in those which emerged from the nests brought into the laboratory. Here, between August 11 and August 30, 34 workers and 217 males became adult. The large number of males here again makes one suspect that the workers probably also had a hand in their production. The ovaries of the queens, it seems to me, would have given out long before this number was attained.

The males have every opportunity now to mate with the few workers that are on hand, and they evidently do so. It is my opinion, expressed elsewhere, that it is the inseminated workers that go into hibernation, and upon coming out of it in the spring become the foundress queens of new colonies.

Table VII is based on the emergence of adults from six *pallipes* nests taken at Pacific, Missouri, two weeks later, August 23, 1939.

TABLE VII

Nest No.	No. of Adults on Nest		No. of Workers to Emerge in Laboratory		No. of Males to Emerge in Laboratory	
	♀	♂	Date	No.	Date	No.
90	7	1	....	......	....	....
91	....	.....	....	0	8/26 to 8/29	10
92	4	4	....	0	8/31	3
93	....	.....	....	0	8/24 to 8/27	7
94	....	....	8/25 to 8/30	6	9/5	1
95	....	......	8/25 to 9/2	3	8/26 to 8/30	5
Total	11	5		9		26

In the table above we see approximately the same condition as noted in Table VI in regard to emergence in laboratory; 26 males emerged August 24 to September 5, as against 9 workers.

POLISTES VARIATUS

The following notes with the same end in view were made on *Polistes variatus*. Thirty-one nests were taken at various places in Missouri on various dates, and all the data is covered in Table VIII.

Adult males did not appear on the nests taken until August 10; on that day the nests taken had 39 workers and 15 males. From the nests brought into the laboratory males did not appear (except two notable exceptions, that will be discussed later) until July 12, and then only a very few in number. The predominating male population came in August.

Since *variatus* is a faster worker than *pallipes* (as may be seen in the earlier pages), there is a hair-breadth chance that the mid-July males may be the progeny of the workers, but the two exceptions referred to,

(the two males which appeared in mid-June in nest 97), can hardly be anything but the progeny of the queen. There is also a record of a male *variatus* becoming adult on June 4 (Ecology 20: 440, 1939). But, unlike Plath's first brood of bumblebees being entirely males, all three early males of *variatus* were members of broods which also had workers;

TABLE VIII

Nest No.	Location	No. of Adults on Nest		No. of Workers to Emerge in Laboratory		No. of Males to Emerge in Laboratory	
		♀	♂	Date	No.	Date	No.
96	Bourbon 5/30/39	1	0	6/10 to 6/15	3	....	0
97	"	1	0	6/5 to 6/16	8	6/16 to 6/20	2
98	"	1	0	6/11 to 6/16	5	....	0
99	"	1	0	6/9 to 6/16	5	....	0
100	Robertson 6/25/39	......	......	7/4 to 7/5	6	....	0
101	"	6	0	7/13	1	....	0
102	"	2	0	....	0	....	0
103	"	4	0	6/26	1	....	0
104	Crescent 6/25/39	5	0	7/5 to 7/12	12	7/12	2
105	Crescent 7/2/39	6	0	7/4 to 7/12	12	7/12	1
106	Wentzville 7/9/39	3	0	7/12 to 7/15	6	....	0
107	"	17	0	7/12 to 7/22	18	7/19 to 7/22	5
108	"	1	0	7/13 to 7/19	3	....	0
109	Allenton 7/10/39	2	0	7/15 to 7/16	6	....	0
110	"	5	0	7/15 to 7/18	4	....	0
111	Ranken 7/25/39	20	0	7/26 to 8/10	11	....	0
112	"	21	0	....	0	7/29 to 8/6	9
113	"	......	......	7/25 to 7/29	3	7/30 to 8/5	7
114	Rosetti 8/5/39	12	0	8/21	3	8/28	4
115	"	......	......	8/13	2	8/6 to 8/25	16
116	"	......	......	....	0	8/6 to 8/20	5
117	"	......	......	8/6 to 8/17	9	8/6 to 8/17	9
118	"	......	......	8/8 to 8/30	7	9/5	1
119	"	......	......	8/16 to 8/21	6	8/13 to 8/21	5
120	Crocker 8/10/39	2	8	8/14	3	8/13 to 8/20	15
121	"	7	5	8/20	1	....	0
122	"	12	0	8/13 to 8/16	8	8/14 to 8/17	2
123	"	18	2	8/15 to 8/17	8	8/15 to 8/26	11
124	"	......	......	8/12 to 8/14	2	8/12 to 8/17	8
125	"	......	......	8/17	1	8/13 to 8/20	9
126	"	......	......	8/13 to 8/17	8	8/14	5
	Total............	......	......	....	......	....	116

indicating, of course, that the foundresses, through accident or otherwise, are capable of depositing infertile male-producing eggs.

With only 3 males appearing before their time in a large number of colonies, one can only say that male production so early in colony founding is unusual.

To conclude, then, the data indicates that both parthenogenetic and fertile eggs are deposited by the foundress queens, but that male egg production early in colony founding is not a normal condition.

More information, however, is needed in this matter. To solve the problem, as already stated, one must by dissection study the ovaries of both workers and queens at various times in the season. One must also know more of the period of incubation and the length of time required to reach adulthood, and last, but not least, one must mark the wasps, and watch them on the nest almost constantly, to discover which kind of wasps deposit which kind of eggs. All this, of course, would require a lot of patience and hard, monotonous toil—I wonder if the problem is worth it.

THE SEX OF POLISTES WASPS THAT EMERGE AT THE END OF THE SEASON

Somehow we have always assumed that in a *Polistes* colony the workers appear first, and continue to emerge from the cells until the middle of summer. Then the males come upon the scene to be in readiness when, finally, toward the close of summer the females arrive. This assumption, however, has no basis in observation or experiment; I, therefore, decided to bring nests loaded with pupae into the laboratory, and note the sexes of the individuals as they emerged from day to day.

In Table IX, I present the data on this problem for three species of *Polistes*, *P. variatus*, *P. pallipes*, and *P. annularis*.

TABLE IX

Variatus				*Pallipes*			
Location in Missouri where Nest was found	Dates when Emergence Occurred in Laboratory	No. that Emerged		Location in Missouri where Nest was found	Dates when Emergence Occurred in Laboratory	No. that Emerged	
	1939	♀	♂		1942	♀	♂
Rosetti	8/8 to 8/25	2	16	Pacific	9/10 to 9/25	5	13
"	8/6 to 8/17	9	5	"	9/3 to 9/11	16	11
"	8/6 to 8/22	6	5	"	9/2 to 9/10	1	9
"	8/13 to 8/23	3	15	Kimmswick	9/20 to 10/17	28	0
Crocker	8/10 to 8/25	18	8	Ranken	9/15 to 10/8	33	0
Ranken	9/13 to 10/15	37	6	Kirkwood	9/14 to 10/5	8	24
				"	9/15 to 10/3	7	21
				Pacific	9/4 to 9/20	6	29
Total	6 nests	75	55		8 nests	104	107
	Annularis						
Kirkwood	9/8 to 10/2 1942	6	64				

The data show that during the last few weeks of the life of the various colonies, there is no regulation in regard to the sex of the emerging population. From most of the nests, both males and females emerged during the last days, although in two nests of *pallipes* the

populations were exclusively female. While the emerging males predominated (226 males and 185 females) in the 15 nests, not one nest gave forth males exclusively. Apparently during the last month of the life of the colony, eggs producing males and females are deposited without any semblance of order or regulation.

Incidentally, let it be noted that the adults that emerged in the laboratory so late in the season would not have been able as larvae or pupae in their natural habitat to withstand the cold of early autumn, but this, however, has nothing to do with the problem of the succession of the sexes.

THE MORTALITY OF POLISTES PALLIPES WORKERS

How many of the workers of Polistes wasps become prey to enemies during the working season? Recently in a population study of ***Bombus americanorum*** I found the mortality of worker bumblebees very low.[2] The study indicated that her bumbling highness has few enemies, and this probably is because she proclaims to the world by her bright dress, the possession of a wicked sting. A study of this kind for bumblebees is quite easy, for the maturing bees leave behind the telltale cocoon from which they emerged. A census which was taken of bumblebees in the nest at night and also of the empty cocoons (both at the end of the season), revealed the fact that only six workers lost their lives in the pursuit of duty during the entire summer.

In watching *Polistes* wasps for several years, I sometimes found that certain workers which I had especially marked failed to return to the nest. *Polistes* workers in their search for wood-pulp, nectar, water, and caterpillars, must spend much time away from home. A proportion of every colony is liable to fall prey to birds, robber flies, and lizards. What this proportion is the following data will show.

To ascertain the degree of mortality among the workers, I removed a number of colonies after dark (when few or none were away from the nests), counted the number of adults on the nest, as well as the number of cells that had disclosed adults. The difference between the two counts would be the number of adults that were lost.

In Table X, I report on 22 nests (Nos. 1 to 22) gathered in Missouri between June 25 and July 13. In these 22 nests I counted a total of 155 cells from which adult wasps emerged, but the number of adults on the nests were only 132 (incidentally, all workers). The loss was, therefore, 23, or an average of one insect per nest. This, of course, is at the height of the season when trips afield are most numerous, and it shows that probably the severe sting of the workers is recognized and respected by the enemies of *Polistes*, as is that of the bumblebee. This date is too early for cells to have been used more than one time for brood. Later in the season the census would have to take into consideration the cells that gave forth more than one adult.

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[2]A Population Study of a Bumble Bee Colony, ***Bombus amtricanorum*** Fab. Ent. News 63: 70-73, 1941.

TABLE X

Polistes pallipes

Nest No.	Date	No. that should be on Nest from a count of the cells[3]	No. actually on Nest		Loss
			♀	♂	
1	6/25	2	2	0	0
2	6/25	7	5	0	2
3	6/25	4	4	0	0
4	6/25	6	6	0	0
5	6/25	7	7	0	0
6	7/9	16	16	0	0
7	7/9	7	5	0	2
8	7/9	6	4	0	2
9	7/9	7	7	0	0
10	7/9	10	9	0	1
11	7/9	6	4	0	2
12	7/9	8	4	0	4
13	7/9	4	3	0	1
14	7/9	4	4	0	0
15	7/9	9	9	0	0
16	7/9	9	7	0	2
17	7/9	4	4	0	0
18	7/9	6	5	0	1
19	7/13	6	6	0	0
20	7/13	10	6	0	4
21	7/13	10	8	0	2
22	7/13	7	7	0	0
Total for 22 nests taken 6/25 to 7/13, 1939.......		155	132	0	23

In Table XI, 15 nests are considered (Nos. 23 to 37); these were taken during the second half of the nesting season, when the colonies were larger, and males appear among the workers on the nests. The table shows that theoretically at least 507 adults should have been on the 15 nests; but what we found was only 260 (123 workers and 137 males), a mortality of about 50%. But the results of the study for the second half of the season will need to be discarded completely because it coincides with the time when the wasps normally disband, and also with the time when often on cold nights workers from elsewhere will alight on nests where they do not belong preparatory to going into hibernation.[4]

There is no way to tell what the mortality of the foraging workers may be during the second half of the season, but the figures are of some slight interest in showing, however, the number of adults that are

[3]In every case the queen was not counted since she did not come from one of the cells.

[4]But perhaps, after all, the defenseless male may be easy prey for enemies, and a 50% loss for the colony at that season may be normal, but since we are here interested only in the mortality of the workers, we can consider the data only for the time when males have not yet appeared on the nests.

TABLE XI

Polistes pallipes

Nest No.	Date	No. that should be on nest, from a count of the cells	No. actually on nest		Loss
			♀	♂	
23	7/25	13	3	5	5
24	7/25	11	5	3	3
25	8/5	17	13	4	0
26	8/5	32	11	16	5
27	8/10	26	14	0	12
28	8/10	10	6	4	0
29	8/10	27	6	9	12
30	8/10	12	3	4	5
31	8/10	27	5	6	16
32	8/10	52	18	20	14
33	8/10	62	8	10	44
34	8/23	15	7	1	7
35	8/23	49	10	5	34
36	9/1	42	5	13	24
37	9/3	112	9	37	66
Total 15 nests taken 7/25 to 9/3, 1939.		507	123	137	247

found on the nests regardless of how they got there, as well as the proportion of the sexes, during the period from July 25 to September 3, a period when mating is in progress.

But it is a pleasure to know at least that the mortality of ***pallipes*** workers during the first half of the season is only 1 per centum. This low mortality is comparable with that found for the also stingful bumblebee.

NOTES ON POLISTES WASPS IN KANSAS

I spent two days, July 6–7, 1942, on the highways of Kansas, collecting the nests of *Polistes* wasps, and noting what I could of their habits. Six species (or rather varieties, according to Dr. Bequaert) were observed, and the details thus gathered are herewith presented.[5]

Polistes fuscatus var. *metricus* Say.—Colonies of this species were taken at Abilene, Junction City, Williamstown, Elkader, and Topeka. The nests are usually round, with the pedicel in the center; they are small in size, much too small, I thought, for that time of the year. Each colony is founded by one queen, and on July 6–7, only three out of thirteen nests had workers, and on these nests never more than two were found. For the others, only the foundress queens were occupants.

The first workers do not appear on the nests until early to middle July. On the day the nests were taken, only 5 workers had emerged

[5]Specimens of Polistes from all the Kansas colonies were submitted to Dr. Joseph Bequaert, who kindly supplied the names.

from 13 nests, but a stream of workers emerged from these nests (when brought into the laboratory) between July 9 and 15.

A count of the cells of 12 nests brought home, revealed that 9 of them contained only 20 to 26 cells, while 3 contained from 35 to 55 cells.

Like many other species of *Polistes, metricus* deposits small drops of honey in the cells containing eggs. In one nest 7 out of 9 egg-bearing cells had droplets of honey, and in another nest all 10 cells with eggs had them.

The width of the cells of *metricus* is no greater than those of *pallipes* or *variatus*, all three varieties having four cells to the lineal inch.

Metricus sometimes is the victim of the lepidopterous parasite, *Calcoela iphitalis* Wlkr. (det. Carl Heinrich). A dozen adults emerged from a nest taken at Williamstown, July 14 to 17.[6]

Bequaert says (Journ. N. Y. Ent. Soc. 48: 21, 1940) that *P. metricus* is common in southeastern and central United States, "and that it should occur in eastern Kansas" which it evidently does.

Polistes fuscatus var. *apachus* de Sauss.—This wasp was only seen in the wind-swept prairie region of western Kansas, at Oakley and Elkader in Scott County.

The nests are few, small, and weak in localities that are wind-driven, but become quite prosperous in nooks sheltered from the wind. This was readily seen by comparing nests in favorable and unfavorable positions. For example, in a wind-swept school yard, a nest in the doorway of a shed had only 8 small cells and no workers, whereas on the same day in an old fashioned garden, protected from the wind by several buildings, the nests were numerous, large, well made, and possessed many workers.

This garden was a veritable oasis in this hot, dry desert, where insects generally were scarce. The profusion of blossoms brought many other insects to the garden, and the *Polistes* did not need to go far for nectar and caterpillars. *Polistes* wasps consume much water, and the large puddle before the wind driven well was well patronized by them.

It is no wonder then, that the one nest taken in the unfavorable location had no workers and only 8 small, weakly built cells; and in the favorable condition of the garden over 30 nests were counted. These were all on the outside or the inside of various buildings, in doorways, under the eaves, and on little lighted ceilings. There were from 8 to 15 workers on the nests, and the six nests brought home had from 30 to 97 cells or an average of 60.5 cells per nest.

The cells, however, were smaller in width than both *metricus* and *variatus*, measuring 4½ to the lineal inch, whereas the latter two species measured 4 to the inch. A nest of *apachus* taken at Rio Grande City, Texas, however, was larger, measuring slightly less than 4 to the inch (Ann. Ent. Soc. Amer. 36: 552, 1943).

These wasps are victims to only a few parasites. One nest gave forth 4 hymenopterous parasites, *Polistiphaga fulva* Cr. (det. H. K. Townes), between July 8 and 15, and another nest had two cells infested

[6]For notes on this parasite see paper, "Observations on Certain Lepidopterous and Hymenopterous Parasites of Polistes Wasps," Ann. Ent. Soc. Am. 34: 355–366, 1941.

by the Indian meal moth, *Plodia interpunctella* Hubn. (det. Carl Heinrich) which became adult in early August. Just how the latter species affected the wasps is not known.

Bequaert (l. c., p. 21) in giving the distribution of this wasp, does not mention Kansas.

Polistes fuscatus var. *bellicosis* Cress.—Only one small nest of seven cells of this wasp was taken on the trip. It was found at Topeka, and even though the season was far advanced, the queen had just commenced building operations. According to Bequaert (l. c., p. 21), this is a common form in Southeastern United States, but he does not specifically record it from Kansas.

Polistes fuscatus var. *variatus*, Cr.—*Polistes variatus* builds in the ground, or near the ground, but occasionally in Missouri one finds them under eaves of buildings. In Kansas, however, according to Iseley and Williams, *P. variatus* often nests in rodent burrows. This species was observed at Junction City, Kanopolis, and Emporia. The nests were small in comparison with those found in Missouri at the same time of year. Four of the five nests collected on July 6–7 had only from 6 to 30 cells, and the fifth nest had 70 cells.

The nests of *variatus* in Kansas were also much more poorly constructed, the paper walls being thin and flimsy. The width of the cells, however, were the same as those taken in Missouri, measuring 4 to the lineal inch.

Polistes canadensis var. *annularis* L.—Nests of *annularis* were not seen, and neither were they searched for particularly, because of the shortness of time. *Annularis* nests in trees near the water, and we kept pretty close to the highways, where old buildings and culverts were examined. However, at Williamstown, an *annularis* was taken while flying, and an inhabitant there told me how hundreds would fly into an attic room of his house each autumn, evidently seeking hibernating quarters. A search among the vegetation near streams would probably reveal them in great abundance in Eastern Kansas.

THE WIDTH OF THE CELL IN RELATION TO THE SIZE OF THE ADULT IN THIRTEEN SPECIES OF POLISTES

Tarlton Rayment has opened a new line of investigation by his discovery of the relation of cell-size to adult-size in five species of honey-gathering bees of the genus *Apis*. He noticed that the cells of the giant-bee of India, *Apis dorsata*, measures 4 to the lineal inch; those of the hive-bee, *A. mellifera*, 5 to the inch; while the eastern honey-bee, *A. indica*, constructs 6 to the same measure. Then there is a hiatus, for the next are those of the Australian bee, *A. aenigmatica*, which measure 9 to the inch, and last, the small cells of the Indian flower-bee, *A. florea*, which builds ten cells to the lineal inch.[7] Rayment, who possesses a good deal of constructive imagination, is looking forward to discovering two new species, whose cells will measure 7 and 8 to the inch. "The sequence will then be unbroken."

Recognizing that Rayment's little study involves three distinct departments of biology—that of taxonomy, psychology, and physiol-

[7]A Cluster of Bees, pp. 554-561, 1935.

ogy—I wondered what his method would reveal when applied to the study of members of the genus of *Polistes*. The adults of each colony or of each species vary but little in size among themselves, but vary to a great extent among the species of the genus.

There is an advantage in working with *Polistes*, over that of members of the genus *Apis*, for in the former, there is no differentiation of size in queens and workers. There are no outward marks of royalty among any of the members of a colony of *Polistes*, nor does a nest contain any large royal cells.

A study of cell-size in *Polistes* was therefore made, and the nests of 13 species were considered.[8] The table herewith presented gives the results of this study.

TABLE XII

Habitat	No. of Nests examined	Polistes species	No. of Cells to the lineal inch
Mexico	6	*P. carnifex*	2¾
Panama	5	*P. panamanensis*	3⅓ to 3½
Mexico	4	*P. major*	3½
Missouri	20	*P. annularis*	3½
Missouri	12	*P. rubigenosis*	3½
Mexico	4	*P. canadensis*	3½
Missouri	15	*P. pallipes*	3¾ to 4
Kansas, Missouri, Wisconsin	20	*P. variatus*	4
Kansas	4	*P. metricus*	4
Mexico	10	*P. instabilis*	4 to 4½
Kansas	9	*P. apachus*	4½
Texas	12	*P. exclamans*	4¾ to 5
Mexico	1	*P. modestus*	5

In Table XII the species are arranged according to the size of the cells; the largest cell-maker being *carnifex* at the top of the column, with 2¾ cells to the lineal inch. Running the eye down the last column, we note a progressive decrease in cell-size, the smallest measuring 5 to the inch, and made by the species *modestus*.

The wasps themselves were not actually measured, but a glance at living or at pinned specimens easily convinces one that there is a very direct correlation between adult-size and cell-size in each of the species represented in the table. Of course, this investigation covers only 13 taxonomic units (species or varieties)—less than a third of those known to North America alone (Bequaert enumerates 45). One wonders, therefore, what may yet be revealed when, and if, a similar study is made for the complete series of *Polistes* wasps from all over the world.

It is quite obvious, of course, that large wasps can only develop to maturity in large cells, but that by no means indicates that small

[8]A number of groups of cells were measured in each nest. The groups chosen for examination were always cells that had already given forth adults. The incomplete or half finished cells usually found about the periphery of the nest were not considered at all.

species cannot also develop in large cells. The observations herein recorded, however, show that no species makes cells larger than are needed. There is something inside queens and workers—be it psychological or physiological—that makes for regulation of cell-size; so much so that it appears as if adults of the various species anticipate the size of the full grown larvae (and this often before even the eggs are deposited) and provide precisely what is required. There is something within the organism—call it mind if you will—that prevents the cells from being built clumsily too wide or uncomfortably too narrow. There is never any wasted space in the cell of a full grown larvae, and if the larvae at first find themselves in cells much too large for them, it is but a tribute to the foresight of the builders in providing "lebensraum" for the young, long before there is need for it.[9]

What is this regulation? What, one may ask, is it that induces a worker to stop building at the right time? Of course one may place the "cart before the horse" and let the answer be that each species instinctively builds cells of a certain size, and that no waspling can possibly grow beyond the limits of its own walls, therefore, we can only expect small wasps from small cells and large ones from large cells. But one must not forget that *Polistes* nests, as well as *Polistes* wasps themselves, were not always what they are today, and that somewhere along the evolutionary line (before the cell-size instincts became fixed in heredity), something akin to intelligence, here and there, entered into the picture. But this only brings us again before a blank wall, because we do not know just how to define intelligence.

Unfortunately, this little study leads us not to any very definite conclusions, although the results of the investigation are of general interest. One cannot yet say that each species or groups of species of *Polistes* may be identified by the kind of cells they make, and thus be of value to the taxonomist. From the standpoint of psychology, we must yet discover what influences each species to build cells of a standard size, and what prevents the builders from making interminably wide cells, or lopsided cells, or what influences them to stop when the proper size was attained.

The one thing that this study has revealed is that *Polistes* wasps (according to species) make cells of different sizes, and these are correlated with the sizes of the adult insects. There are, however, many details of the causes and the evolution of this correlation about which we know nothing. Tarlton Rayment has, however, opened a new avenue of attack on these problems by his study of the genus *Apis*, and a similar attack upon *Polistes* may lead to discoveries of value about the interrelationships of members of the genus *Polistes*.

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[9]The length of the cells in some species is increased as the larvae within them come to maturity, and in some species, *i.e.*, *annularis*, the cells are seldom long enough to completely enclose the larvae. Often we find the length increased to some extent, not by paper pulp, but by heavy silk spun by the larvae, but this of course has nothing to do with the width of the cell, which is entirely the work of adults.

ADULT ODONATA AS CLASS-ROOM MATERIAL

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For a number of years the writer has employed Dragonflies (Anisoptera) and Damselflies (Zygoptera), in a beginners' course in Entomology to exemplify a laboratory period entitled "The Interdependence of Modifications in Structure."

Visitors from other Universities have expressed surprise at the explanation for their structure which is given here. Though several have stated that they find it interesting, all appear to reserve judgment as to the validity of our deductions. This paper is written with the hope that it may either justify our interpretation or induce someone, better versed in the actual facts than we are ourselves, to refute it.

The writer lays no claim to being a specialist, either in morphology or in the Order Odonata. These insects were selected as laboratory material simple because they are readily procurable. This selection necessitated an attempt to interpret their unusual structural modifications along biological and physical lines. Reference to such literature as was available to us failed to elicit any explanation for the remarkable lengthening of the abdomen other than as a somewhat vague reference to "Streamlining."

The sequence employed in laboratory periods which precede a study of these insects may clarify the arguments herewith presented.

Following introductory periods, designed to place Arthropoda, in general, in their correct perspective in relation with other forms of animal life, a combined study is made of the external anatomy of grasshoppers and roaches. Either of these insects, if studied alone, gives a false impression of the structure of a generalized pterygote insect, since each is highly specialized in certain respects.

Studied together, however, they exemplify nearly every important structure (excepting wing venation) in a moderately unmodified form. The students are asked to retain a mental composite picture of these primitive Hexapod structures and are told that every variation of them which they will encounter in subsequent studies of other insects must have some biological significance even though, in the present state of our knowledge, that significance may elude a satisfactory explanation.

These periods are immediately followed by a combined study of a dragonfly and a damselfly. The period begins with a brief account of the habits of each insect. Dissimilarities between their use of vision in locating prey and the similarity in their method of its capture and subsequent manipulation, with the aid of all six legs, are discussed. The students are then told that it is the latter habit which is associated with the extreme lengthening of the abdomen. In order to prove this to themselves they are required, first, to make an enlarged drawing of the thorax and to homologize every structure with that of a more generalized grasshopper.

Since the modifications are more pronounced in a damselfly than they are in a dragonfly, the greater attention is paid to the former insect, though the latter yields information regarding the difference in the employment of vision, while it serves as an example of an intermediate stage in thoracic modification.

By the end of the period, each student is required to explain:

1. How and why the cervical region has become more flexible than is that of a phytophagous grasshopper.
2. How "bi-focal" vision serves the needs of a dragonfly, while it is unnecessary in the method whereby the damselfly searches for prey.
3. By what actual modification of the pterothorax are all three pairs of legs brought to lie immediately below the mouth, where they can together produce a "wastepaper-like" basket for scooping prey from the air and, subsequently, assisting the highly predatory mandibulate mouthparts to deal with it.
4. Why this unusual method of catching prey results in the lengthening of the abdomen, and produces its unusual shape in Zygoptera.

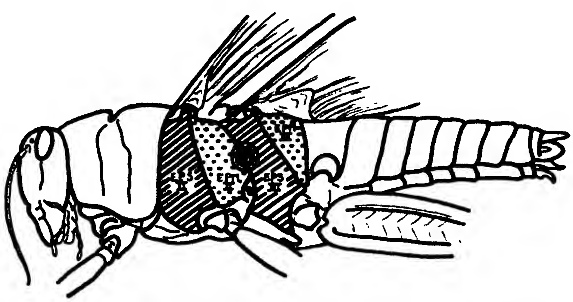

FIG. 1. A generalized insect, exemplified by a grasshopper, showing its center of balance supported above in flight and below when walking by the wings and legs, respectively. Eps. II and III, Epm. II and III., Meso- and Meta- Episterna and Epimera, respectively. The "target" indicates the approximate center of balance.

A solution to the last two problems is approached as follows: In comparison with the more generalized grasshopper thorax, it is observed that the pterothorax has undergone a 45° rotation in the dragonfly and one approaching 90° in the damselfly. The biological significance of these rotations, obviously, is that they bring all three pairs of legs to a position below the mouth, where they are ideally suited to capture prey flying in front of this predator and to manipulate it subsequent to capture.

To the extent to which this rotation serves its purpose in bringing the legs forward to perform this new task, it, at the same time, forces the wings backward to a similar degree. In consequence, the two fulcra of support by the legs and by the wings now lie the one well in front of, and the other far behind the original centre of balance of the entire body. The accompanying diagram illustrates this "shift" in

comparison with the condition which maintains in a more generalized grasshopper.

Evolution has done little to rectify this situation in so far as leg support is concerned. Though field observations demonstrate that a damselfly is still able to rest on a horizontal surface it rarely does so, but it hangs, by preference, to a vertical support. All pretensions to "running" have had to be permanently discarded.

Flight, however, remains an activity of paramount importance in the ecology of a damselfly. Without some compensating modification to the region behind the wings, the "head-heaviness" resulting from their backward migration would render this an impossibility.

Some degree of "tail-heaviness" in insects is no serious obstacle to flight. This condition is common, particularly in the case of females at those times during which the abdomen is heavily loaded with eggs. The actual centre of balance, in such insects, in the natural course of events, is continually shifting with the operation of the essential functions of ingestion and excretion and of gonad activities. Some compensation for this can be effected by varying the backward sweep of the wings and by accentuating, or otherwise, a downward flexure of the abdomen. Such expedients, however, are entirely ineffective in re-establishing equilibrium to a head-heavy insect such as a damselfly.

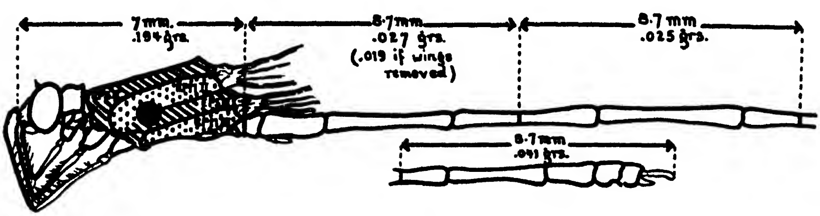

FIG. 2. A male *Lestes*, showing the 90° rotation of the pterothorax, which brings the original center of balance to a point far in advance of the wing bases. The total weight of this insect was .289 grs., of which .194 grs. lay in front of the wing-base, and only .095 grs. behind it. After removal of the hind pair of wings, the abdomen weighed only .087 grs.; of this weight .041 grs. was confined to the posterior third of its length. The center of balance for the entire insect, after removal of the wings, is about 2 mm. *behind* the wing base.

The necessity for the great "depth" between the nota and the sterna of the Zygopteran pterothorax is not very obvious. The following conjecture is offered as a possible explanation. Flight muscles in primitive insects evolved along lines whereby they actuate the wings to deliver a powerful lifting stroke, at right angles to the nota, while, at the same time, driving the insect forward. From this ancestral muscle pattern has evolved the present muscular arrangement within the pterothorax of Zygoptera which permits them still to fly *upwards* and forwards rather than *backwards* and upwards. It is possible that the consequent modification in the relative development of the interacting flight muscles could be effected only by an increase in the distance between the nota and the sterna of the segments which contain them.

Whatever may be the explanation, this secondary deepening of the

pterothorax has accentuated an already pronounced head-heaviness in Zygoptera.

Two adaptational modifications suggest themselves as a possible means for restoring equilibrium. The first is that an otherwise unmodified abdomen increase in size and in weight until it counterbalances the entire weight of the head and thorax. Had the course of evolution been along these lines, however, the total weight of the insect would have been greatly increased. This would have necessitated still more powerful flight muscles and, presumably, a still larger and heavier pterothorax. Since muscular power increases only by the square of its diameter whereas its weight increases by its cube, this course appears to have been denied by one law of physics.

In actuality, however, another physical law was "at the disposal" of evolutionary modifications to reinstate equilibrium. Its application to the Zygopteran abdomen is clearly seen in the accompanying diagrams. By actual weight, the abdomen of the specimen illustrated was found to be only .095 grs., which is rather less than half of the .194 gr. weight of the combined head and thorax. Furthermore, it can be shown, by thrusting a pin horizontally through the abdomen of a male Zygopteran and resting its ends on smooth surfaces, that the actual centre of balance in this insect now lies approximately 2 mm. ***behind*** the wings, near the junction of the 2nd and 3rd abdominal segments.

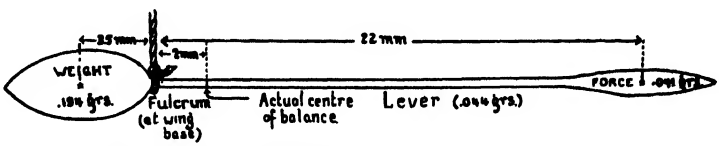

FIG. 3. Diagram, showing the application of "The first law of leverage" to the equilibrium of a flying Zygopteran.

A number of individuals, representing both sexes of various species of Zygoptera, chief among which was ***Lestes unguiculatus*** Hag., were weighed. Despite the similarity in size, the females of any given species weighed about 1½ times to twice as much as did the corresponding males, while the weight of their abdomens in comparison with that of the head and thorax varied considerably according to the condition of gonad development. In the males, however, results were much more uniform. The one illustrated can be taken as fairly typical.

In all males, bisected by a vertical cut between the two pairs of wings, the anterior half of the body weighed from 1½ to over two times as much as did the posterior half.

Trisection of the abdominal region indicated the extent to which its chief weight is localized posteriorly. As is shown in the chart, the posterior third is almost as heavy as is the anterior two-thirds after removal of the hind pair of wings. Further dissection of this posterior third indicated that its weight is fairly evenly distributed along its length. The slight discrepancies between the total weight of the abdomen and its component thirds is due to small losses of blood resulting from dissection.

The greatest weight of the combined head and thorax appears to centre around the middle of the pterothorax, near the point occupied by the centre of balance of a complete generalized insect. Bleeding, when this region is cut, prevented accurate weighing of its parts.

From this, it appears that, because a weight of .194 grs., centered at a point about 3.5 mm. in front of a fulcrum at the wing-bases, can be counterbalanced by one of only .041 grs. at a distance of about 20 mm. behind it, equilibrium has been restored to a Zygopteran with a saving of more than 25% of a total body weight.

Theoretically, the leverage afforded to the lesser weight should enable it to counterbalance a weight of about 6 times its own magnitude in front of the fulcrum. Despite the added assistance of the weight of the "lever" in a Zygopteran abdomen, its posterior third has to counterbalance only about 4½ times its own weight. As was demonstrated earlier, however, the actual point of balance in this insect lies behind the fulcrum and, in common with other insects, a Zygopteran is somewhat "tail-heavy" in flight.

Thus an early study of this insect focuses the attention of the student upon the following facts:

1. A biological explanation should always be sought for every one of the innumerable structural modifications which he will encounter in the different species of insects that he will study.

2. Because no ready explanation can be found in the case of some of these, it cannot be assumed that they are an exception to this rule. (Attention is, however, drawn to the possibility that some, such as the long legs of Tipulidae, which appear to be an unmitigated nuisance to most of their present-day possessors, may have served an invaluable purpose in the evolutionary history of these essentially aquatic insects, while there is the probability of a genal linkage of "neutral," or possibly somewhat disadvantageous, characteristics with others of which the advantages more than offset them.)

3. All adaptational modifications are conditioned by immutable physical laws. Compensatory modifications, which may be demanded, may find expression in parts of the body which are far removed from the region in which the original modification evolved in association with a new employment of an ancestral structure.

THE ELATERIDAE OF NEW YORK STATE, by HENRY DIETRICH. Cornell University Agricultural Experiment Station, Memoir 269, 79 pages, 4 plates, March, 1945.

While the treatment of the insect fauna of a single state may be of little value beyond its limits, the study of such a difficult group as the Elateridae even for a restricted area must have been a task worthy of any taxonomist's skill and the results in Dr. Dietrich's article are likely to be widely helpful. The Memoir is almost wholly a taxonomic survey. After a brief preliminary statement on the Elateridae of the world, the purpose of the paper, and acknowledgments, the writer devotes a page to general characters and methods of collection and proceeds to the classification. Keys to the genera and to the species of each genus are accompanied by brief descriptions and records of distribution. References to the bibliography are sporadic. Six pages are devoted to larvae. The four plates are made up of zinc etchings of beautifully executed drawings, including morphological details, genitalia, and several figures of larvae. The work concludes with an index of scientific names.—A. W. L.

THE COMPARATIVE MORPHOLOGY OF INTERNAL STRUCTURES OF THE ASILIDAE (DIPTERA)[1]

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Comparatively little investigation has been made on the internal anatomy of flies other than the blood-sucking groups and a few others of economic importance, and a great number of the works published have dealt only with the anatomy of larvae. There are a great number of families of Diptera with diverse habits and external morphology whose internal anatomy would seem worthy of investigation. It was for such a reason that the Asilidae were chosen for this study. The robber flies because of their large size and predaceous habits have always aroused interest with the result that several investigators have published on robber flies and their prey. In connection with their feeding habits several descriptions have been made of the mouthparts of asilids. A few of these articles have described the gross structure of some parts of the alimentary canal lying in the head. Dufour (1851) made a comparative study of the internal anatomy of six European species of Asilidae, but other than his works the publications that include descriptions of the internal anatomy of the Asilidae have for the most part dealt with only certain organs of the robber flies in comparison with those of other Diptera. Thus the knowledge of the internal anatomy and particularly the histology is very scanty.

This paper deals with the comparative anatomy and histology of the digestive tract and its associated organs, male and female internal reproductive organs, and the dorsal vessel and related organs of the circulatory system in four species of Asilidae. The species studied are *Asilus notatus* Wied., *Erax rufibarbis* Macq., *Promachus bastardi* Macq., and *Proctacanthus milbertii* Macq. All of these species belong to the subfamily Asilinae. As to size they range in length from around 18 mm. in *Asilus* to 30 mm. in *Proctacanthus* with the other two being about equal in length, around 24 mm. General descriptions of organs and tissues except when otherwise noted apply equally well to all four species studied. Since all work was done on preserved material, descriptions of color and appearance may not be applicable to fresh specimens.

Material for study was collected in the summer of 1944. *Asilus*, *Promachus*, and *Proctacanthus* were collected while the author was a student at the University of Michigan Biological Station, Cheboygan, Michigan, where robber flies were found in great numbers along the sandy roads and fire-lanes. *Erax* was collected in the late summer on a dry hillside in Athens County, Ohio. Including both males and females from 25 to 150 specimens of each species were obtained.

The author wishes to express his sincere appreciation to Dr. C. H.

[1]Thesis presented for the degree of Doctor of Philosophy.

Kennedy, of the Department of Zoology and Entomology, Ohio State University, for his advice and kindly criticism during the preparation of this paper. The author also wishes to thank Dr. Stanley W. Bromley, of the Barlett Tree Research Laboratories, Stamford, Conn., who identified the species used in this study, and Mr. R. E. Snodgrass, of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, who was consulted for the proper terminology of the glands associated with the mouthparts.

METHODS

All specimens were first killed with cyanide. Then to insure a better penetration of the fixative the legs and wings were removed and the thoracic and abdominal cavities were opened up widely by cutting the body wall lengthwise with fine scissors. The incision was not made on the same surface in all the individuals of a species. In some it was dorsal, in others it was ventral or lateral. Those having a lateral incision were found to be most satisfactory in dissection. To kill and fix the tissues the insects were put immediately into Kahle's fluid. After thoroughly washing the material in 70% alcohol it was preserved in alcohol of the same percentage.

Gross dissection.—For studying the gross anatomy of an insect it was pinned in a dissecting pan and covered with 70% alcohol. Dissections were made with the aid of a Greenough type binocular microscope. Drawings of gross anatomy were with a few exceptions made free-hand. Several whole mounts, particularly of the dorsal vessel and Malpighian tubules, were made, and these were studied and drawn with the use of a microprojector and microscope. Whole mounts were stained with either Mayer's carmalum or Heidenhain's iron-haematoxylin, run through the alcohols, and cleared in cedar oil.

Histological technique.—To make orientation in imbedding easier and to render small pieces of material easier to locate in all steps up to sectioning, the organs or desired parts of organs were generally stained in toto with Mayer's carmalum before running them through the alcohols. From 100% alcohol the tissues were cleared in cedar oil and imbedded in paraffin. Sections of most tissues were cut both seven and ten microns thick. The most satisfactory staining method employed Mayer's carmalum for staining in toto and fast green for counterstaining. Other stain combinations used were haematoxylin and fast green, Mallory's triple connective tissue stain, and Heidenhain's iron-haematoxylin. Drawings showing cellular structure were made either with the use of a camera lucida or a microprojector. All drawings made using the microprojector are of the same scale except Figure 44, which is of a lower magnification. Drawings done with the camera lucida are so indicated in the explanations of the plates and have a magnification approximately three times greater than those for which the microprojector was used.

SUCKING MECHANISMS OF ROBBER FLIES

Asilids by the possession of a powerful sucking apparatus are well equipped for sucking the blood and softer tissues of their prey consisting of numerous species and various sizes of insects.

In the asilids there are, as in many other sucking Diptera, two sucking pumps, one immediately following the other. The first, or cibarial, pump is not a true part of the alimentary canal being evolved from the preoral cibarial pocket of such insects as the cockroach, but in Diptera the functional mouth opens into it (Snodgrass, 1944). The second, or pharyngeal, pump being a modification of the pharynx is really the first part of the alimentary canal.

Cibarial pump.—(Pl. I, Figs. 7 and 10). The cibarial pump was termed as "basipharynx" by Peterson (1916), who states that it "is interpreted as including all of the united portions of the epipharynx and hypopharynx." Whitfield (1925) adopted this term "basipharynx" in his description of the mouthparts of asilids. Melin (1923) termed the cibarial pump as the pharynx. All of these writers have ascribed a pumping power to this structure.

The floor of the cibarial pump is formed by a sclerotized plate articulating with the hypopharynx and which, as explained by Snodgrass (1944), is the base of the hypopharynx. This hypopharyngeal plate is trough-shaped, becoming wider above and having two lateral processes, or cornua, between which the lower part of the pharyngeal pump is attached. These processes are circular in form and serve as points of muscle attachments. These cornua of the cibarial pump have been termed the cornua of the basipharynx by Peterson (1916), and as "cornua pharyngis" by Melin (1923). Whitfield (1925) describes the two sets of muscles attached to the cornua as being the ones responsible for extruding and retracting the hypopharynx. The anterior wall of the cibarial pump is formed from the epipharyngeal part of the clypeus. This plate is sclerotized but is flexible and is attached by dilator muscles to the median plate of the clypeus. When the muscles are relaxed the anterior wall fits closely against the posterior wall.

Pharyngeal pump.—The second, or pharyngeal, pump was considered by Melin (1923) as being a swollen front part of the oesophagus having a pumping power. Peterson (1916) and Whitfield (1925) term this pump as the oesophageal pump.

The pharyngeal pump is precerebral in asilids as in the horse fly (Snodgrass, 1944). It is a top-shaped structure with its lower part being held firmly between the cornua of the cibarial pump (Pl. I, figs. 7 and 10). The pharyngeal pump has a funnel-shaped cavity with the apex leading from the cibarial pump (Pl. I, fig. 3). The sides of the cavity are lined with a chitinous intima which is continuous above with a thick chitinous disc which shows a central cup, or depression, when the muscles are relaxed. This plate extends between the muscle fibers for most of its circumference and can be seen externally (Pl. I, fig. 10). Surrounding the chitinous intima and the dorsal disc is an epithelial layer of flattened cells. The pharyngeal pump is supplied with powerful muscles. The walls of the pump are composed of many layers of muscle fibers most of which are circular, but some have an oblique arrangement. The dorsal disc of the pump is attached to the frontal wall of the head by a large dilator muscle. The musculature of the pharyngeal pump is covered externally by a layer of low epithelial cells which appear vacuolated and resemble fat tissue. These in turn are covered with the walls of the tracheal air sacs of the head.

The chitinous framework of the dorsal disc and the intima of the funnel are prolonged posteriorly forming a narrow, angular tube that passes between the lobes of the brain to join the oesophagus which begins in the neck (Pl. I, fig. 1). This part of the pharynx is covered externally by a low epithelial layer. At the junction of the prolongation of the pharynx and the beginning of the oesophagus are attached four muscles, two above and two below, which are attached inside the posterior wall of the head. Whitfield (1925) says these control the passage of the food from the pharyngeal pump into the oesophagus.

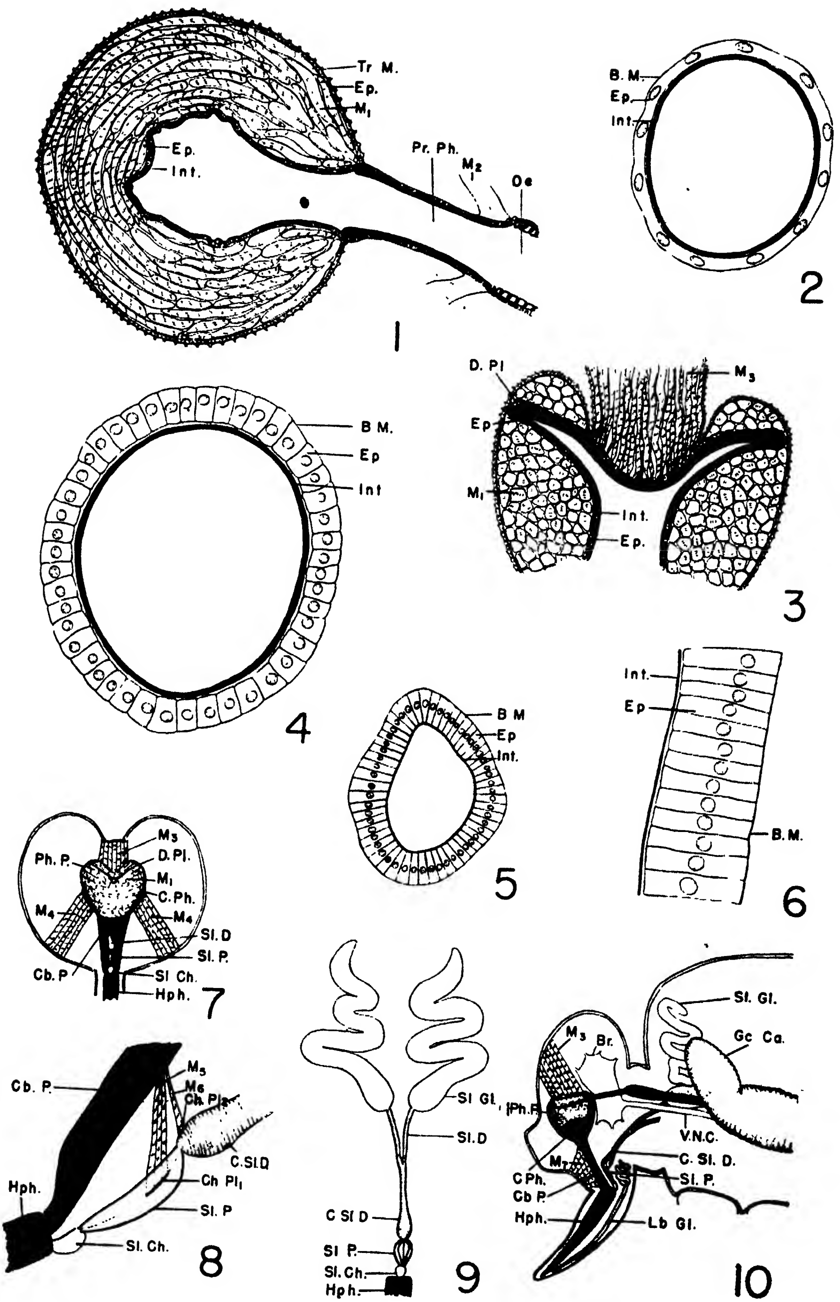
GLANDS ASSOCIATED WITH THE MOUTHPARTS

Two separate pairs of glands open into the proboscis. Whitfield (1925) thought he was the first to discover the presence of the smaller pair, but Cholodkovsky (1900) had found them in *Laphria*. He termed the larger pair mandibular glands and Whitfield spoke of them as thoracic salivary glands; while both termed the smaller pair labial glands. Whitfield thought it probable that the thoracic glands secrete a poison and that the labial glands are truly salivary in function.

Two pairs of glands associated with the mouthparts and opening separately are found in some other Diptera. Lowne (1893–95) described two sets in *Calliphora*, and Kraepelin (1883) and Hewitt (1914) have done likewise for *Musca*. All these writers have termed as lingual those that end in the hypopharynx and labial those that are connected with the labium. They considered the lingual ones as being truly salivary. This brings about a confusion in terminology for Snodgrass (1935) states that so-called "salivary glands" opening at the base of the hypopharynx would be better termed labial glands. Since the function of neither pair has been determined, they cannot be designated as to their secretion. For the purposes of this paper those lying in the thorax and opening through the hypopharynx will be termed "thoracic glands" and those lying in the labium as "labial glands."

EXPLANATION OF PLATE I

FIG. 1. *Proctacanthus*, longitudinal section through the pharyngeal pump, the prolongation of the pharynx, and oesophagus. 2. *Erax*, cross section of a paired thoracic gland duct. Camera lucida. 3. *Proctacanthus*, dorso-ventral section of the pharyngeal pump. 4. *Erax*, cross section of thoracic gland common duct. Camera lucida. 5. *Erax*, cross section of thoracic gland. 6. *Promachus*, wall of thoracic gland. Camera lucida. 7. *Proctacanthus*, posterior view of sucking apparatus. 8. *Proctacanthus*, lateral view of salivary pump. 9. *Proctacanthus*, ventral view of thoracic glands. 10. *Proctacanthus*, lateral view of organs of head and first part of thorax. *B. M.*, basement membrane; *Br.*, brain; *Cb. P.*, cibarial pump; *Ch. Pl.*$_1$, chitinous plate on salivary pump; *Ch. Pl.*$_2$, chitinous plate on common duct of thoracic glands; *C. Ph.*, cornu of cibarial pump; *C. Sl. D.*, common duct of thoracic glands; *D. Pl.*, dorsal plate of pharyngeal pump; *Ep.*, epithelium; *Gc. Ca.*, gastric caecum; *Hph.*, hypopharynx; *Int.*, intima; *Lb. Gl.*, labial Gland; M_1, circular and oblique muscles of pharyngeal pump; M_2, dilator muscles of opening into oesophagus; M_3, dilator muscle of pharyngeal pump; M_4, muscles attached to cornu; M_5, dilator muscle of salivary pump; M_6, dilator muscle of common thoracic gland duct; M_7, dilator muscle of cibarial pump; *Oe.*, oesophagus; *Ph. P.*, pharyngeal pump; *Pr. Ph.*, prolongation of pharynx; *Sl. Ch.*, duct leading to salivary channel; *Sl. D.*, paired duct of thoracic glands; *Sl. Gl.*, thoracic gland; *Sl. P.*, salivary pump; *Tr. M.*, tracheal membrane; *V. N. C.*, ventral nerve cord.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Thoracic glands.—(Pl. I, fig. 9). The thoracic glands are a pair of white elongate, sac-like tubes lying folded in the thorax in front of and partially between the gastric caeca (Pl. II, fig. 11, and Pl. III, figs. 17–19). The free end of each extends laterally and above the gastric caecum and is held in place by a connective tissue which surrounds it and the gastric caecum. The thoracic gland walls have a layer of uniform columnar epithelium (Pl. I, figs. 5 and 6). The epithelial cells have large round nuclei. This layer is lined internally with a smooth chitinous intima and on the outside there is a thick basement membrane, which in some sections appears as if it were a separate peritoneal membrane. Cholodkovsky (1900) described epithelial degeneration as occurring in the thoracic glands of *Laphria* in even a stronger degree than in the mid-gut, but epithelial degeneration was never observed in the thoracic glands in the present study.

The separate ducts of these glands unite below the oesophagus and nerve cord to form a common duct which leads to the salivary pump at the base of the hypopharynx (Pl. I, figs. 9 and 10). Both the individual and the common ducts have the same general appearance and structure. Their external brownish coloring is due to the spiral thickenings of the chitinous intima similar to but thinner than that of the oesophagus. This spiral chitinous lining has been noted by Adler and Theodor (1926) in *Phlebotomus*, by Tullock (1906) in *Stomoxys*, by Hewitt (1914) in *Musca*, by Lowne (1893–95) in *Calliphora*, and by Jobling (1933) in *Glossina*. Unlike the oesophagus these ducts exhibit great elasticity in that they can be considerably stretched without breaking. The epithelial layer of the individual ducts is flattened and cell walls are not distinct, while the common duct has an epithelium of distinct cuboidal cells (Pl. I, figs. 2 and 4). No muscle fibers are present on the ducts, but the secretion from the glands is pumped into the salivary channel of the hypopharynx by the salivary syringe, or pump.

The salivary pump is a structure which is present in all Diptera (Snodgrass, 1944). It has been termed the salivary syringe or salivary bulb by different authors. Peterson (1916) observed that the salivary bulb is a chitinized structure continuous with the hypopharynx in *Tabanus*, but separated from the hypopharynx in *Promachus*. Whitfield (1925) gives drawings and a description of the salivary pump and its

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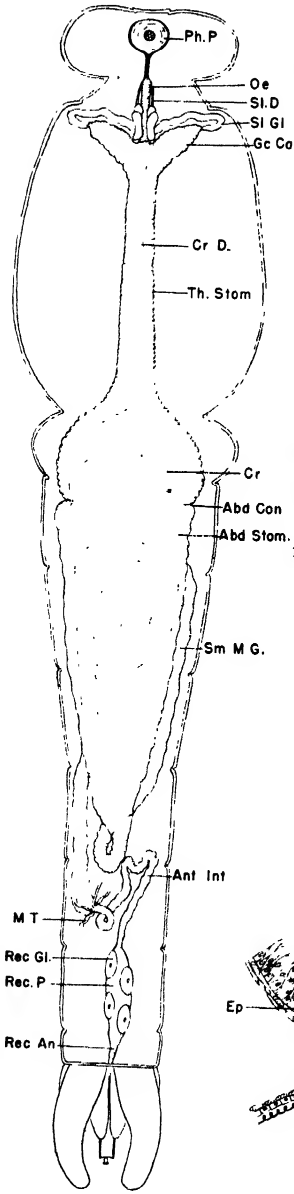
EXPLANATION OF PLATE II

FIG. 11. *Proctacanthus*, alimentary canal. 12. *Proctacanthus*, cross section through region of oesophageal valve. 13. *Asilus*, longitudinal section of oesophageal valve. 14. *Asilus*, upper part of oesophageal valve. Camera lucida. 15. *Erax*, upper part of oesophageal valve. Camera lucida. 16. *Erax*, longitudinal section of oesophageal valve. *Abd. Con.*, abdominal constriction of stomach; *Abd. Stom.*, abdominal portion of stomach; *Ant.,Int.*, anterior intestine; *Ao.*, aorta; *B. M.*, basement membrane; *C. M.*, circular muscle; *Cr.*, crop; *Cr. D.*, crop duct; *Ep.*, epithelium; *F. Cls.*, fat cells; *Gc. Ca.*, gastric caecum; *Int.*, intima; *L. M.*, longitudinal muscle; *Mus.*, musculature; *M. T.*, Malpighian tubule; *Oe.*, oesophagus; *Ph. P.*, pharyngeal pump; *Pt. M.*, peritoneal membrane; *Ptr. M. Cls.*, cells lying in the position of those which secrete the peritrophic membrane of Diptera; *Rec. An.*, anal part of rectum; *Rec. Gl.*, rectal gland; *Rec. P.*, rectal pouch; *Sc. Gb.*, secretory globule; *Sl. D.*, paired duct of thoracic glands; *Sl. Gl.*, thoracic gland; *Sm. M. G.*, smaller portion of mid-gut; *Th. Stom.*, thoracic portion of stomach; *Tn. Int.*, taenidium of intima; *Vl. F.*, epithelial valve fold.



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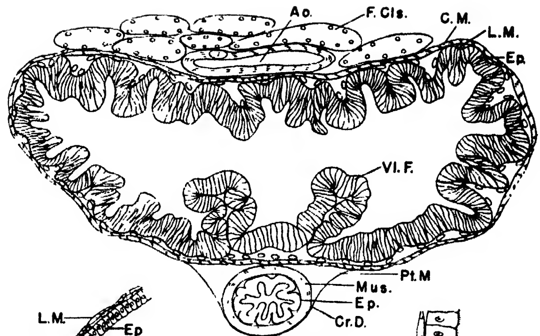

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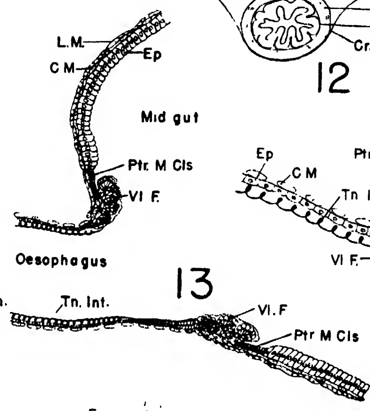

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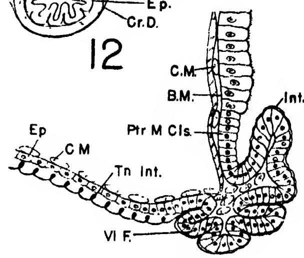

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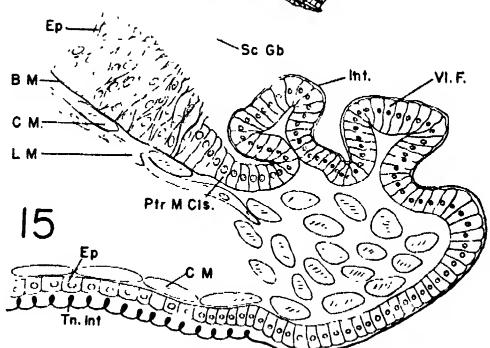

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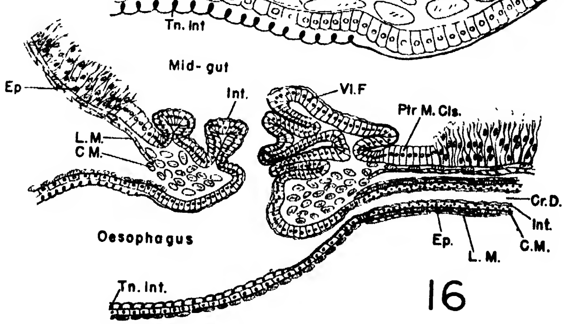

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method of operation in the asilids. The salivary pump functions in forcing the secretion of the thoracic glands out through the terminal outlet duct in the hypopharynx.

The duct connecting the salivary pump and the salivary channel within the hypopharynx is a thin, chitinous, bulb-like structure (Pl. I, fig. 8). This duct as well as the pump itself is covered with a membrane which is supposedly a continuation of the epithelium of the thoracic gland ducts. The pump is a thicker chitinous structure with narrow, sclerotized, strengthening ridges on its posterior wall (Pl. I, fig. 9). It is roughly oval in outline when seen from behind. Its posterior, or lower, wall is spoon-shaped with its convexity downward, and the anterior, or upper, wall when relaxed is nested in the lower wall. The posterior wall is fairly rigid, but the anterior wall is flexible and has a sclerotized central area on which a pair of dilator muscles are inserted whose other ends have their origin on the posterior wall of the cibarial pump. From a small chitinous area on the dorsal wall of the common salivary duct immediately behind the pump a small dilator muscle is inserted which has its origin on the posterior wall of the cibarial pump.

Labial glands.—Whitfield (1925) was able to detect the presence of labial glands only in *Machimus atricapillus* Fall. and in *Asilus crabroniformis* T. His descriptions and drawings of these species closely agree with the structures as found in *Asilus notatus* Wied. but those of the other species examined in this study are of a different conformation.

In *Asilus notatus* Wied. the labial glands are small, paired glands lying wholly within the labium on each side of the mid-line and opening separately near the tip of the labium. They show folds but no coils (Pl. IV, fig. 29). In *Erax, Proctacanthus*, and *Promachus* the labial glands lie for part of their length in the same position as in *Asilus*, but in these species the glands are longer and extend beyond the base of the labium into the lower part of the head capsule where they lie in coils (Pl. I, fig. 10, and Pl. IV, fig. 26).

In histological structure the labial glands in all four species are essentially alike (Pl. IV, figs. 25 and 27). Each consists of epithelial cells clustered around a duct formed of spirally thickened chitinous intima. This latter shows through the epithelium and can be seen as a thin, brownish line, particularly in *Asilus*. The epithelial cells are large, columnar cells rounded at their outer ends. Their nuclei, like those of the thoracic glands, are large. The epithelium is composed of

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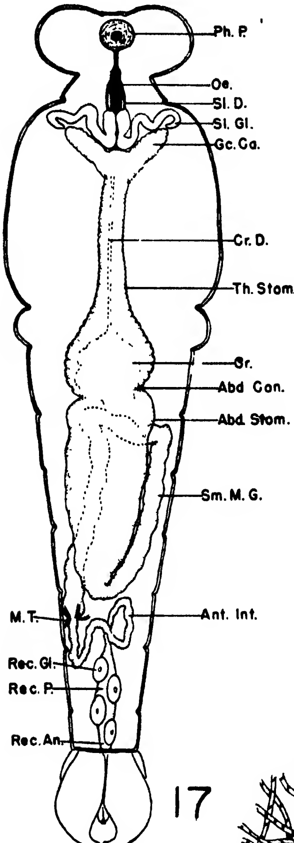
EXPLANATION OF PLATE III

FIG. 17. *Erax*, alimentary canal. 18. *Asilus*, alimentary canal. 19. *Promachus*, alimentary canal. 20. *Proctacanthus*, portion of crop showing musculature. 21. *Proctacanthus*, crop wall. Camera lucida. 22. *Erax*, ventral view of attachment of crop duct. 23. *Proctacanthus*, cross section of crop duct. 24. *Proctacanthus*, cross section of crop. *Abd. Con.*, abdominal constriction of stomach; *Abd. Stom.*, abdominal portion of stomach; *Ant. Int.*, anterior intestine; *B. M.*, basement membrane; *Cr.*, crop; *Cr. D.*, crop duct; *Ep.*, epithelium; *Gc. Ca.*, gastric caecum; *Int.*, intima; *M. T.*, Malpighian tubule; *Mus.*, muscle; *Oe.*, oesophagus; *Ph. P.*, pharyngeal pump; *Rec. An.*, anal part of rectum; *Rec. Gl.*, rectal gland; *Rec. P.*, rectal pouch; *Sl. D.*, paired duct of thoracic glands; *Sl. G.*, thoracic gland; *Sm. M. G.*, smaller portion of mid-gut; *Th. Stom.*, thoracic portion of stomach.



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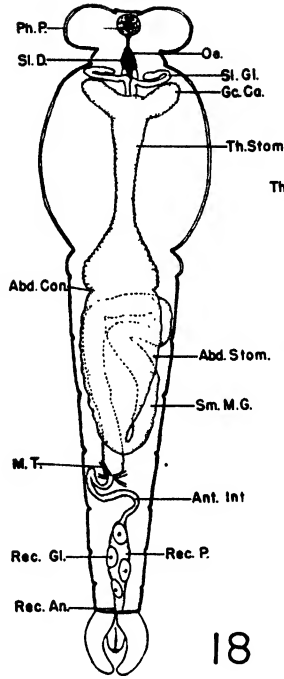

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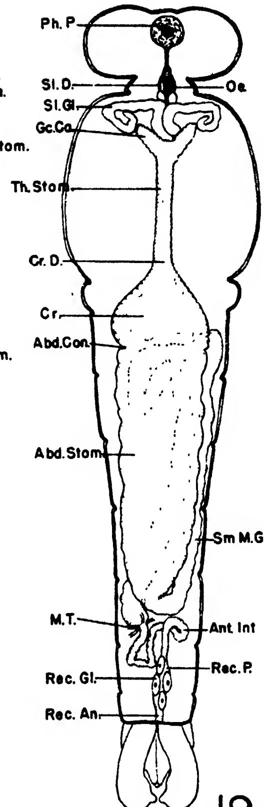

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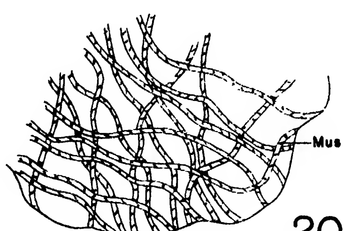

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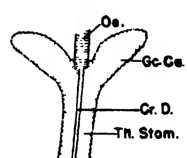

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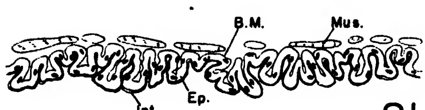

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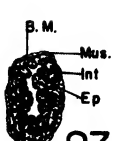

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only one layer of cells, but due to their irregular arrangement they may appear to be in two layers in parts of cross sections. Eight to fourteen cells appear in a cross section. The labial glands have no covering nor limiting membrane other than the basement membrane of the epithelium.

THE ALIMENTARY CANAL

Following the terminology used by Snodgrass (1935) for all insects, the lining of the alimentary canal of asilids is divisible into three main regions according to origin: that of the fore-gut, or stomodaeum, ectodermal in origin; that of the mid-gut, or mesenteron, endodermal in origin; and that of the hind-gut, or proctodaeum, again ectodermal in origin. All three regions are covered with muscles which are mesodermal in origin. The division between the fore- and mid-gut is marked by the oesophageal valve; the division between the mid- and hind-gut by the pyloric valve and the attachment of the Malpighian tubules. The regions can also be distinguished by the presence of a chitinous intima in the fore- and hind-gut.

The alimentary canal varies in length with the degree of expansion and the state of muscular contraction, but is roughly one and one-half to twice the length of the entire body. Loops occur in the abdominal mid-gut and in the hind-gut (Pl. II, fig. 11, and Pl. III, figs. 17–19).

FORE-GUT

The fore-gut consists of four distinct parts. The first part of the fore-gut is the pharynx which is modified into the pharyngeal pump and has been described above as part of the sucking apparatus. The other parts of the fore-gut are the oesophagus, the oesophageal valve, and the oseophageal diverticulum, or the crop.

Oesophagus.—The oesophagus is a tube which begins immediately back of the head where it is continuous with the ending of the pharynx. It is distinctly larger in diameter than the posterior prolongation of the pharynx (Pl. I, fig. 1). It extends through the neck and into the thorax where it connects with the anterior end of the mid-gut. It is rather uniform in diameter throughout its length, but it is expansible and becomes swollen when filled with food. The oesophagus has a brownish color and a ringed appearance similar to that of the tracheae. This appearance is due to the thick chitinous intima which has sclerotized spiral thickenings (Pl. II, figs. 14 and 15). Like the tracheae this intima can be pulled out into long spiral threads. Dufour (1851) described the annular striae of the oesophagus as being unlike the spirals of the tracheae in that they were discontinuous, but Cholodkovsky (1900) described the oesophagus of *Laphria* as having the structure of a trachea. The epithelium is composed of low or cuboidal cells which appear lower when the oesophagus is distended with food (Pl. IV, figs. 33 and 34). These cells lie on a basement membrane. Surrounding the epithelium is a well-developed layer of circular muscles. No longitudinal muscles were found. This same condition of musculature was found by Graham-Smith (1934) in *Calliphora erythrocephala* L. The muscles are covered for part of the length of the oesophagus by the walls of tracheal air sacs.

Oesophageal valve.—(Pl. II, figs. 12–16). Just anterior to the mid-gut the epithelial cells of the oesophagus begin to increase slightly in height, and with the folding of the epithelium into the mid-gut forming the oesophageal valve these cells become low columnar in form. There are usually two or three deep folds of epithelium in the oesophageal valve. The chitinous intima of the oesophagus loses its spiral structure just anterior to the mid-gut. It becomes thinner and continues as a very delicate and barely perceptible membrane covering the epithelial folds of the valve. Surrounding the junction of the oesophagus and mid-gut are several strong bands of circular muscles.

The oesophageal valve of *Asilus* differs from that of the other species studied in that the folds of cells are much more weakly developed leaving a comparatively larger opening between the oesophagus and stomach. It may be possible that there is some correlation between this poor development of the oesophageal valve and the absence of the crop in *Asilus.*

In the anterior end of the mid-gut surrounding the oesophageal valve and covered by its folds is a ring of cells about ten rows in extent (Pl. II, figs. 14 and 15). In size and structure these cells are more like the cells of the fore-gut than of the mid-gut. In gross dissection these cells have a glossy surface which is quite different from the dull surface of the surrounding epithelial cells of the mid-gut. They are low columnar in form and do not have vacuoles as in many of the mid-gut epithelial cells.

No peritrophic membrane was found in the asilids, but these cells described above lie in the same position as those in other Diptera from which the peritrophic membrane is generally considered to be secreted. (Wigglesworth 1930 and 1939). Most authors have considered these cells as belonging to the mesenteron and thus endodermal in origin, but Gambrell (1933) in working out the embryology of *Simulium* found these cells to be ectodermal in origin, and Butt (1934) says the peritrophic membrane is ectodermal in origin in *Sciara* arising from a group of large secreting cells lying around the oesophageal valve and attached to the upper edge of the mid-intestine.

Crop.—A crop is present in ***Erax***, ***Promachus***, and ***Proctacanthus***, but there is no vestige of one in *Asilus.* Dufour (1851) found a crop in *Dasypogon* but not in *Asilus* nor *Laphria.* Neither did Cholodkovsky (1900) mention a crop in *Laphria.*

The crop in the asilids is a diverticulum of the fore-gut (Pl. II, fig. 16, and Pl. III, fig. 22). Its duct opens through a ventral slit in the oesophagus just in front of the mid-gut. The duct is a small straight tube lying below and loosely connected lengthwise with the ventral surface of the thoracic portion of the stomach. On its entrance into the abdomen there is a rapid enlargement of the duct into the crop which lies in the first part of the abdomen below the stomach and above the ventral diaphragm.

The crop is a delicate, thin-walled structure whose surface is very irregular with many wrinkles and a lobate outline. It is lined with a chitinous intima which is thrown into numerous folds (Pl. III, figs. 21 and 24). The epithelium, which like the intima has many complex folds, is composed of flat cells in which the nuclei are distinct but cell

walls are not. The epithelium rests upon a basement membrane. The musculature consists of an irregular meshwork of flat fibers which do not completely cover the surface when the crop is expanded (Pl. III, fig. 20). It is this irregularity of the musculature which allows the bulging of the crop wall to form the irregular surface outline. The crop is not covered with a continuous peritoneal membrane, but it is usually surrounded by large masses of fat tissue. When the crop is contracted it is difficult to locate if there is much fat tissue investing it, but its presence or absence in a species can be determined by whether or not its duct is present.

The crop duct is very similar in histology to the crop with a chitinous intima and flat epithelium thrown into complex folds (Pl. III, fig. 23). The musculature is a little more complete, generally showing a layer of external circular fibers and scattered, internal, longitudinal fibers.

The crop is generally considered to be a temporary food reservoir, but in the asilids no food was ever found in the crop even when the oesophagus and stomach were filled with food; however, in different individuals the crop showed varying degrees of expansion. Similarly, Patton and Cragg (1913) working with *Tabanus* which uses vertebrate blood never found fresh blood in the crop even in flies killed while in the act of feeding. According to Wigglesworth (1939) the crop functions in various ways in different Diptera.

MID-GUT

The major part of the alimentary tract of asilids is the mid-gut. It lies in both the thorax and the abdomen. The anterior end of the mid-gut is prolonged laterally into two large gastric caeca, the apices of which are connected to the thoracic wall by suspensory ligaments. Histologically these gastric caeca are quite similar to the remainder of the thoracic portion of the stomach (Pl. IV, fig. 28).

Between the origins of the gastric caeca and where it passes into the abdomen the stomach does not change much in diameter, but as it passes through the foramen between the thorax and abdomen it widens and reaches its maximum diameter in the first abdominal segment (Pl. II, fig. 11, and Pl. III, figs. 17–19). The thoracic portion of the stomach and the first part in the abdomen generally have deep annular folds (Pl. V, fig. 36). The first part of the stomach in the abdomen is separated from the remainder by a very deep constriction, but there is no internal valve. Behind this constriction the mid-gut is large in diameter until it loops forward and backward under itself. This

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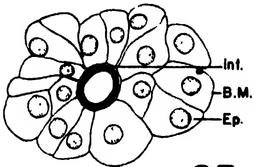
EXPLANATION OF PLATE IV

FIG. 25. *Asilus*, cross section of labial gland. Camera lucida. 26. *Erax*, labial glands. 27. *Proctacanthus*, cross section labial gland. Camera lucida. 28. *Proctacanthus*, cross section of gastric caecum. 29. *Asilus*, left labial gland. 30. *Promachus*, cross section of abdominal part of stomach anterior to constriction. Camera lucida. 31. *Proctacanthus*, cross section of smaller portion of mid-gut. 32. *Proctacanthus*, wall of abdominal part of stomach posterior to constriction. Camera lucida. 33. *Proctacanthus*, wall of oesophagus. Camera lucida. 34. *Proctacanthus*, cross section of oesophagus. 35. *Proctacanthus*, cross section of smaller portion of mid-gut. *B. M.*, basement membrane; *C. M.*, circular muscle; *Ep.*, epithelium; *Int.*, intima; *L. M.*, longitudinal muscle; *Rg. Cls.*, regenerative cells; *Sc. Gb.*, secretory globule; *St. Br.*, striated border.



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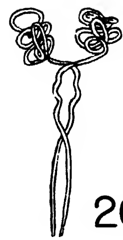

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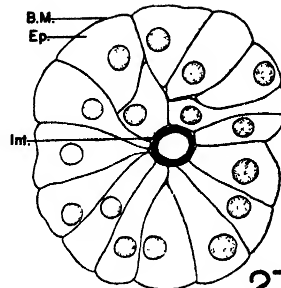

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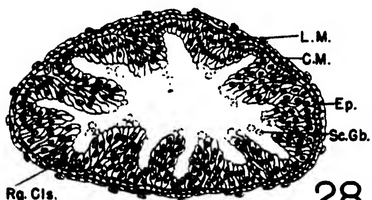

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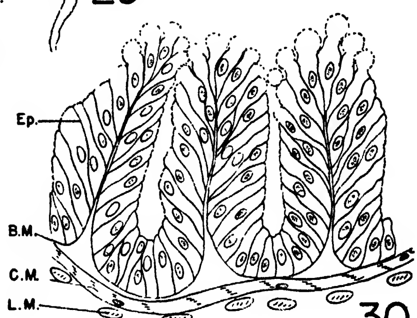

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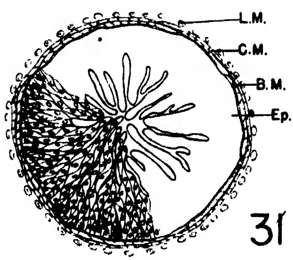

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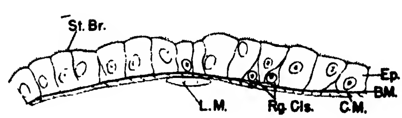

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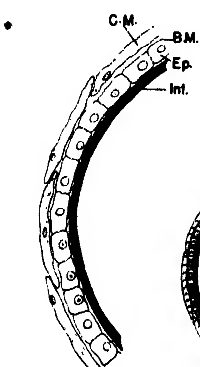

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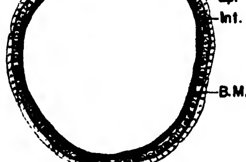

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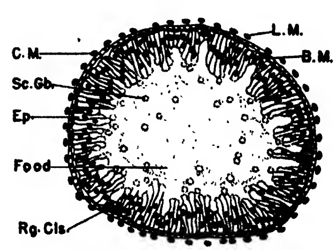

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looped portion is generally much smaller in diameter than the preceding portion of the stomach but the relative diameters vary according to the position of food portions. All of the mid-gut posterior to its abdominal constriction generally has a much smoother external surface than that of the thoracic and abdominal portions preceding the constriction.

Histology of mid-gut.—Throughout its length the wall of the mid-gut consists of a layer of columnar epithelial cells bounded by a basement membrane surrounded by well-developed layers of internal circular and external longitudinal muscles. A continuous peritoneal membrane was not found to be present around the abdominal portion of the stomach, but one was usually found around the thoracic portion.

The epithelial layer appears quite different according to the stages of secretion and muscular contraction, but there does not appear to be any essential difference in structure in the various sections of the mid-gut. The epithelium is made up of a single layer of columnar cells, but due to the muscular contraction they may be so distorted and heaped up that there may appear to be several layers (Pl. V, fig. 37). The epithelium of the thoracic and first abdominal sections of the stomach is generally found to be thrown into deep circular folds. A longitudinal section in this case shows the circular muscles quite regularly spaced within the folds, but the longitudinal muscles bridge the folds (Pl. V, fig. 36). A cross section of the same region may at the same time show longitudinal folds, and sometimes the abdominal portion of the stomach may show very deep longitudinal folds (Pl. IV, fig. 30). In general the epithelial cells of the mid-gut show considerable irregularity as to height, the cells which are actively secreting being much higher than the others. At times the mid-gut, particularly the smaller looped portion, may be so contracted that the epithelial cells almost close the lumen (Pl. IV, fig. 31).

The nuclei of the mid-gut epithelium are generally large and oval. In the resting state the epithelial layer frequently shows a striated inner border (Pl. IV, fig. 32). The cells generally appear vacuolated.

A peritrophic membrane could not be found in the asilids. As evidence of its absence the secretory globules and particles were frequently found dispersed among the food particles (Pl. IV, fig. 35). Patton and Cragg (1913) stated that while the peritrophic membrane is a well-defined structure in muscid flies no definite membrane exists in the Orthorrhapha at least in *Culex* and *Tabanus* which were carefully studied, but that a delicate, faintly staining layer could be distinguished under the most favorable conditions. However, Jahn (1930) states that the peritrophic membrane appears as a distinct non-cellular membrane in the mydas fly.

Secretion.—Secretion in the asilids is of the holocrine type in that large globules or cell particles are freed from the cells into the lumen. In sections of the mid-gut in which active secretion is occurring the epithelial cells may appear to be drawn out into long necks subtending buds at their inner ends (Pl. V, fig. 38), or a globule may appear to be forming at the free end of the cell with no neck-like constriction (Pl. IV, fig. 30). In either case the free ends of the cells not having globules have a vacuolated appearance. During active secretion globules are found not only at the ends of the cells, but also free in the lumen where

the globules are found scattered in the food (Pl. IV, fig. 35). In addition to the production of non-cellular globules a secretion is sometimes found in which the secreted particles contain nuclei and appear to be small cells (Pl. V, fig. 37). The two processes sometimes appear to occur together, but more frequently they do not appear to be contemporaneous in the same section. Cholodkovsky (1900) says that evidently some of the cells completely degenerate and are replaced by others. This secretion in which nucleated particles or cells are secreted has been described for other orders of insects, and in the Diptera it has been described for *Tabanus* (Cragg, 1920).

The disintegrating epithelial cells are apparently replaced by groups of small regenerative cells located between the groups of larger secreting cells (Pl. IV, figs. 37 and 38).

Pyloric valve.—(Pl. V, fig. 42). The pyloric valve is formed by folds of epithelial cells of the mid-gut extending backward into the hind-gut leaving a narrow opening into the hind-gut. Around the junction of the mid- and hind-gut there are a few bands of circular muscles, but this circular musculature is much more poorly developed than that of the oesophageal valve. The Malpighian tubules open into the hind-gut beneath the folds of the valve and seemingly at the union of the mid- and hind-gut (Pl. V, fig. 41).

HIND-GUT

The hind-gut of asilids may be divided into four portions. The first of these has one or more loops and extends from the pyloric valve to the rectal valve. It is not divisible into an ileum and a colon, but is a fairly uniform tube and will thus be termed simply as the anterior intestine. The opening between the anterior intestine and the posterior intestine is conrtolled by a rectal valve. The posterior intestine, or rectum, is a straight tube with no loops. Two regions may be distinguished, the rectal pouch, or rectum proper, containing the rectal papillae, and the remainder of the hind-gut leading to the anus which Graham-Smith (1934) has designated the anal part of the rectum.

Anterior intestine.—(Pl. V, figs. 39–42). Internally this portion has a chitinous intima lining the cuboidal epithelium. The epithelium may be thrown into relatively shallow folds in comparison with that of the mid-gut. The nuclei are more or less spherical. The epithelium lies on a thin basement membrane. A fairly thin but uniform layer of circular muscles is present, but there is not a definite layer of longitudinal muscles. However, in the anterior portion occasional longitudinal fibers lie external to the circular muscles. A similar musculature was found by Graham-Smith (1934) in *Calliphora*. In the posterior portion just in front of the rectal pouch occasional internal longitudinal fibers are found, but in most sections, particularly in the middle portion, longitudinal fibers are not found. A peritoneal membrane generally surrounds this and the other regions of the hind-gut.

Rectal valve.—(Pl. VI, fig. 44). The rectal valve is more weakly developed than the pyloric valve. Immediately anterior to the expansion of the rectal pouch, there is a perceptible increase in the thickness of the circular musculature with an aggregation of more bands of fibers. The epithelial folds of the valve are formed from the epithelium of the

posterior intestine rather than being an extension of the epithelium of the anterior intestine, thus being different in structure from the oesophageal and pyloric valves. The epithelial folds are covered next to the lumen with the chitinous intima which is continuous throughout the hind-gut.

Rectal pouch.—(Pl. VI, figs. 43–45). The rectal pouch is an enlarged, oblong, bladder-like portion of the posterior intestine which contains four rectal glands. The chitinous intima and the epithelium of the pouch are thrown into numerous, complicated folds. In the epithelium small, oval nuclei are present, but cell walls are not distinct. The musculature is highly developed, consisting of external circular bands in one or two layers and numerous internal longitudinal fibers. The latter lie for the most part between the folds of the epithelium. Occasionally one or a few external longitudinal strands appear to be present. The musculature is surrounded by a peritoneal membrane.

In the asilids included in this study and those examined by Engel (1924) four rectal glands were found in all species, but Dufour (1851) described five in *Dasypogon* and *Asilus senex* Meig. The rectal glands are papilliform in structure with their apices extending backward in the lumen of the rectal pouch. Externally their bases are seen as button-like, raised structures on the surface of the rectum (Pl. II, fig. 11, and Pl. III, figs. 17–19). Generally they are arranged alternately with two on each side of the dorsal side of the rectum, but sometimes they may appear in a long row and again they may be displaced more laterally. Engel (1924) describes and diagrams them as being on the ventral side in the female *Machimus atricapillus* Fall. and says that this same arrangement holds for all species studied by him which included *Leptogaster cylindricus* Deg., *Dioctria rufipes* Deg., and certain exotic asilids. In the present study the rectal papillae were found on the dorsal side in both males and females in all species. In rare cases they were found on the ventral side in a few females, but other females of the same species showed them in their typical dorsal position so that their ventral position is not considered as being normal, rather being due to displacement by enlarged ovaries or some other cause.

The epithelium of the rectal papillae is composed of giant cells with large nuclei. This epithelium is apparently continuous with the flat epithelium of the rectal pouch. The surface of a papilla is covered with an intima which is continuous with that lining all of the hind-gut. The lumen of the papilla is narrow, funnel-shaped. It is lined with a

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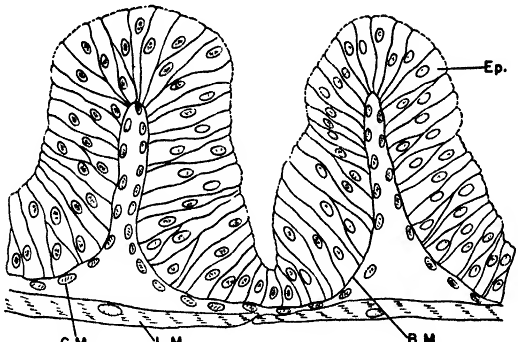
EXPLANATION OF PLATE V

FIG. 36. *Asilus*, longitudinal section of thoracic portion of stomach. Camera lucida. 37. *Proctacanthus*, wall of smaller portion of mid-gut showing secretion of cellular particles. Camera lucida. 38. *Proctacanthus*, wall of smaller portion of mid-gut showing formation of secretory globules. Camera lucida. 39. *Proctacanthus*, cross section of anterior intestine near pyloric valve. 40. *Proctacanthus*, wall of anterior intestine. Camera lucida. 41. *Promachus*, longitudinal section through pyloric valve showing attachment of a Malpighian tubule. Camera lucida. 42. *Promachus*, longitudinal section of pyloric valve. *B. M.*, basement membrane; *C. M.*, circular muscle; *Ep.*, epithelium; *Int.*, intima; *L. M.*, longitudinal muscle; *Pt. M.*, peritoneal membrane; *Rg. Cls.*, regenerative cells; *Sc. Cl.*, secretory cellular body; *Sc. Gb.*, secretory globule; *St. Br.*, striated border; *Vl. F.*, epithelial valve fold.



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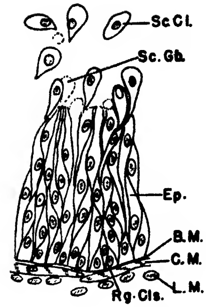

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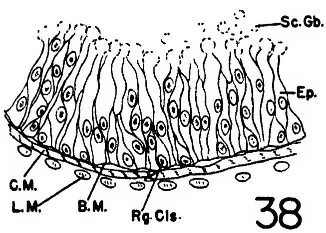

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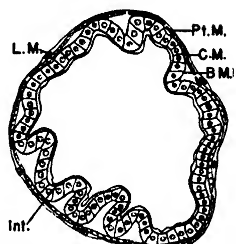

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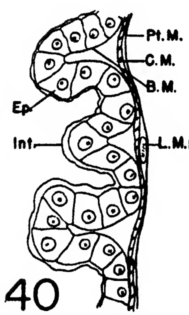

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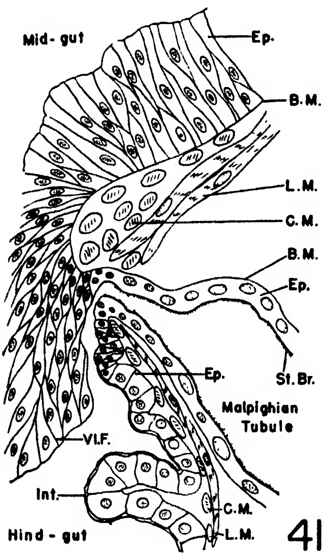

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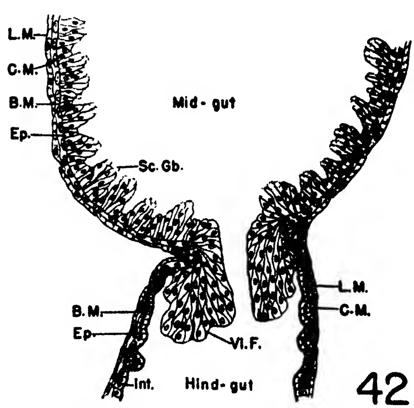

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thin peritoneal membrane and contains several tracheal branches which come from usually two tracheae that enter the base. The base of the papilla interrupts the musculature of the rectum and has no muscular coat. A peritoneal membrane covers the base of the gland.

Graham-Smith (1934) describes the histology of the rectal papillae of *Calliphora* in elaborate detail; he suggests that the large cells may function like liver cells. Engel (1924) who made a morphological and histological comparison of the rectum of Diptera says that carbonic acid is removed from the blood by the epithelial cells and that the rectal papillae of the imago mechanically destroy the peritrophic membrane. Wigglesworth (1932) thinks they absorb water and thus conserve it.

Anal part of rectum.—(Pl. VI, fig. 46). Behind the rectal pouch the posterior intestine becomes narrowed again into the anal part of the rectum which leads to the anus. This part of the rectum shows practically the same histological structure as the rectal pouch, minus the papillae, in that its walls are composed of a similar intima, epithelium, and musculature.

MALPIGHIAN TUBULES

There are four Malpighian tubules in the Asilidae all of which are inserted separately, as has been described by Dufour (1851) and Schindler (1878). They are not evenly spaced as to their insertion, but are arranged in two pairs. The Malpighian tubules arise at the junction of the mid- and hind-gut, and are generally considered as being ectodermal in origin (Snodgrass, 1935, and Johannsen and Butt, 1941), but Pantel (1898) stated that the Malpighian tubules of the larva of *Thrixion* belong by their insertion to the mid-gut and not the hind-gut; in a later paper (1914) in observations on the Malpighian tubules of the Nematocera he described them as being inserted in the mid-gut. Eastham (1924) considered the Malpighian tubules of Diptera as being endodermal in origin arising from the mid-gut, and Henson interprets them as being endodermal in *Pieris* (1932) and in *Blatta* (1944).

The Malpighian tubules are slender, long tubes whose free ends extend into all of the abdominal cavity, but they were never found in the thorax. They are white in all species except *Asilus*. Each specimen examined of this species, regardless of sex, had some white tubules, but others in the same individual contained a bright red pigment. This pigment is not free in the lumen but is contained in the cells (Pl. VII, fig. 48). Sometimes pigment granules are found in the cells of other species, but not in sufficient amount to give a distinct coloration to the Malpighian tubules. The epithelial cells forming the walls of the tubules rest upon a thick basement membrane. They are shaped and

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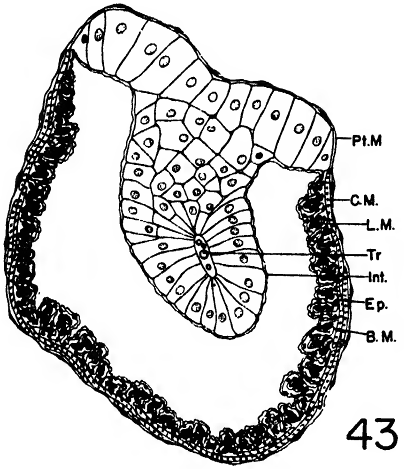
EXPLANATION OF PLATE VI

FIG. 43. *Promachus*, cross section through rectal pouch. 44. *Proctacanthus*, longitudinal section through rectal pouch. (Less highly magnified). 45. *Proctacanthus*, longitudinal section through rectal pouch showing the fourth rectal papilla. 46. *Promachus*, wall of anal part of rectum. Camera lucida. *B. M.*, basement membrane; *C. M.*, circular muscle; *Con. T.*, connective tissue; *Ep.*, epithelium; *Int.*, intima; *L. M.*, longitudinal muscle; *Mus.*, musculature; *Pt. M.*, peritoneal membrane; *Tr.*, trachea.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B.M.

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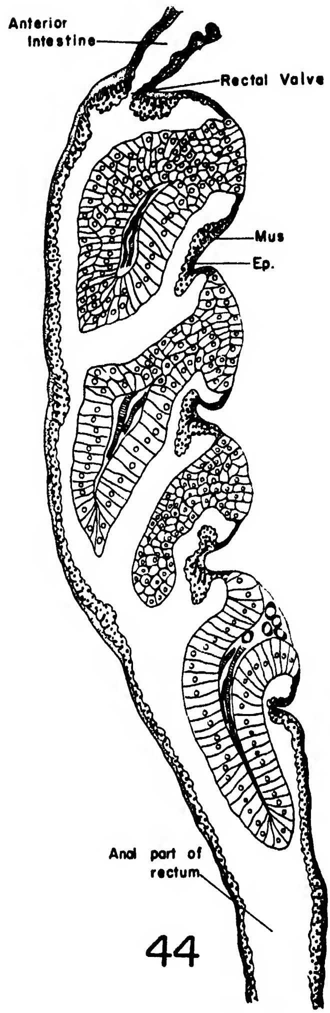
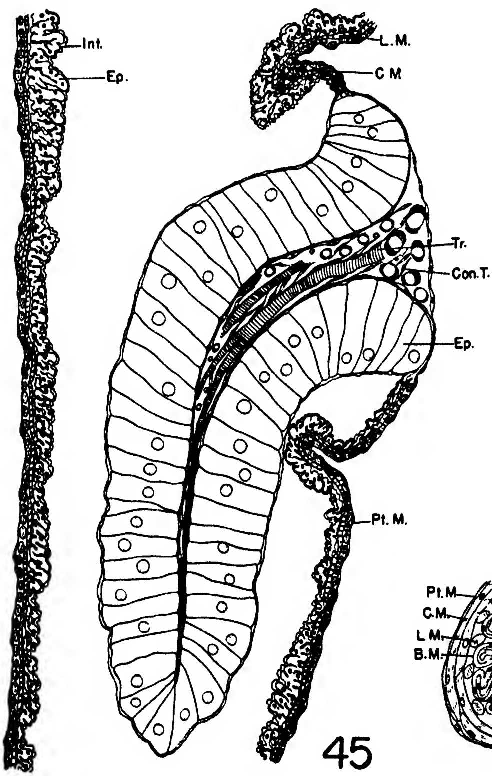

Anterior Intestine
Rectal Valve
Mus
Ep.
Anal part of rectum

44


Int.
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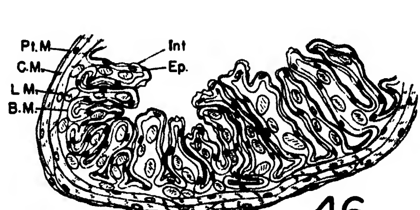
Pt.M
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L M.
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Int
Ep.

46

alternately arranged in such a manner that not more than two cells appear in a true cross-section (Pl. VII, figs. 48 and 49). They contain large nuclei which frequently cause a bulging of the cell into the lumen. The side of the cell facing the lumen has a striated border similar to that sometimes found in the epithelial cells of the mid-gut, but here the striae are longer and more distinct, appearing cilia-like in structure. No continuous peritoneal membrane surrounds the tubules, nor were muscular fibers found on them.

Occasionally small nucleated strands can be found on the outside of the tubules, but these are not striated and are supposedly ultimate divisions of the tracheae distal to the termination of the tracheal taenidia as Patton and Cragg (1913) described them for *Tabanus* (Pl. VII, fig. 47). In some whole mounts small cells can be seen which appear to lie between the large cells, but these are perhaps peritoneal cells or cells of tracheal endings.

INTERNAL FEMALE REPRODUCTIVE ORGANS

Dufour (1851) studied the gross anatomy of the female organs of four species of Asilidae: *Laphria fulva* Meig., *Dioctria nigritarsis* Nob., *Dasypogon teutonus* F., and *Asilus crabroniformis* T. He illustrated the organs of *Asilus*. Dufour thought, in opposition to Loew (1841), that the spermathecae were "sebific" glands and that the accessory glands were the sperm receptacles.

The female reproductive organs of asilids consist of two large ovaries, the lateral oviducts which unite into a common oviduct leading to the vagina, a pair of accessory glands, and the spermathecae.

Ovaries.—(Pl. VII, figs. 50 and 53). The ovaries are large and elongate, and consist of numerous ovarioles. They taper toward the anterior end where the tips of many of the ovarioles come to a point. The anterior end of each ovary is attached to the dorsal membrane by means of a suspensory ligament. This ligament is not formed by the union of the terminal filaments of the ovarioles, but it is a continuation of the peritoneal sheath which envelops each ovary. The two ligaments do not unite to form a median filament but are inserted separately. The ovaries are also held in position by the tracheae which penetrate between the ovarioles. There are usually fifty or more ovarioles in each ovary of all the species studied. Melin (1923) found that eggs of a smaller species (*Laphria flava*) were larger and fewer in

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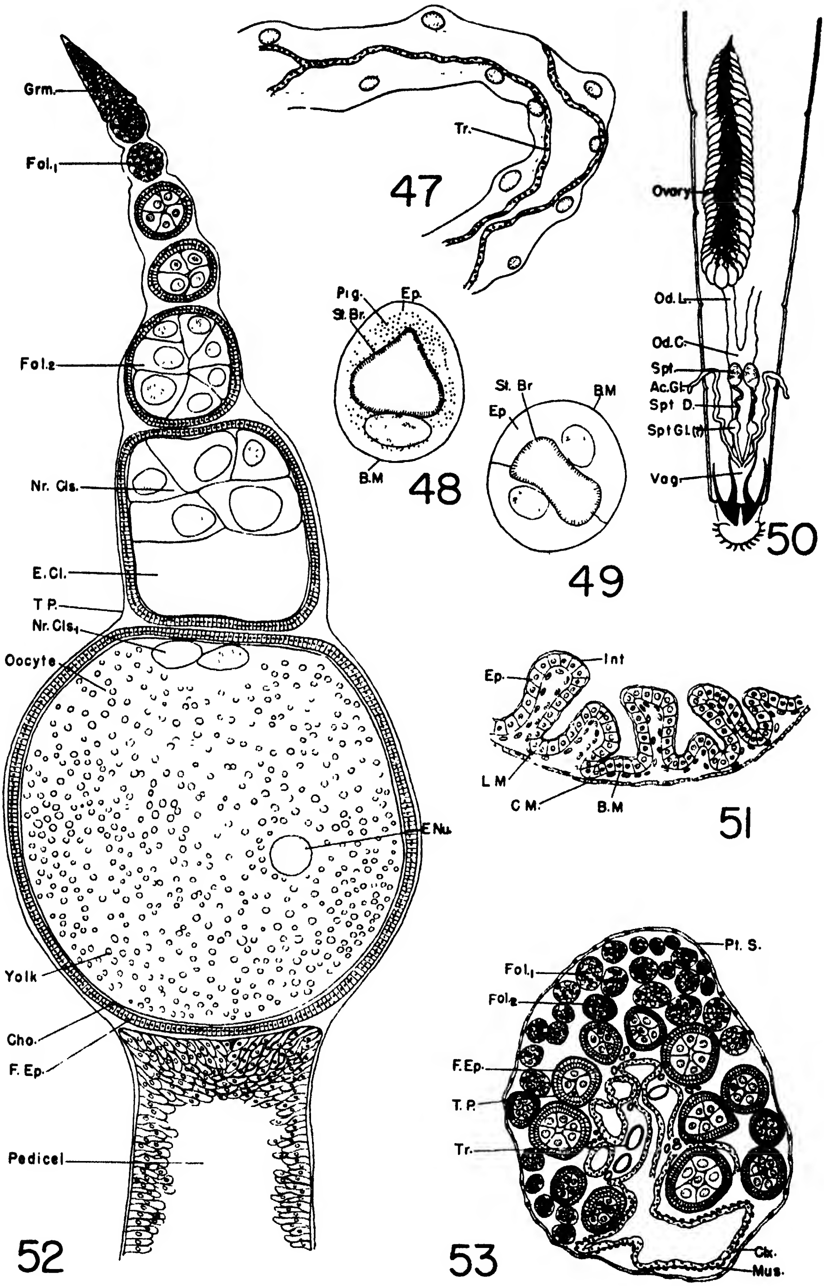
EXPLANATION OF PLATE VII

FIG. 47. *Erax*, Malpighian tubule. 48. *Asilus*, cross section of Malpighian tubule. Camera lucida. 49. *Erax*, cross section of Malpighian tubule. Camera lucida. 50. *Proctacanthus*, female reproductive organs, right ovary removed. 51. *Asilus*, wall of lateral oviduct. Camera lucida. 52. *Proctacanthus*, longitudinal section of an ovariole. 53. *Erax*, cross section of ovary near anterior end. *Ac. Gl.*, accessory gland; *B. M.*, basement membrane; *Cho.*, chorion; *Clx.*, egg calyx; *C. M.*, circular muscle; *E. Cl.*, egg cell; *E. Nu.*, egg nucleus; *Ep.*, epithelium; *F. Ep.*, follicular epithelium; *Fol.*$_1$, young follicle; *Fol.*$_2$, older follicle; *Grm.*, germarium; *Int.*, intima; *L. M.*, longitudinal muscle; *Mus.*, musculature; *Nr. Cls.*, nutritive cells; *Nr. Cls.*$_1$, remnants of nutritive cells; *Od. C.*, common oviduct; *Od. L.*, lateral oviduct; *Pig.*, pigment granules; *Pt. S.*, peritoneal sheath; *Spt.*, spermatheca; *Spt. D.*, spermathecal duct; *Spt. Gl.* (?), spermathecal gland (?); *St. Br.*, striated border; *T. P.*, tunica propria; *Tr.*, trachea; *Vag.*, vagina.


Tr.
47
Pig.
Ep.
St. Br.
B.M
48
St. Br
BM
Ep
49
Ovary
Od. L.
Od. C.
Spt.
Ac. Gl.
Spt D.
Spt Gl.(?)
Vag.
50
Int
Ep.
L M
C M.
B.M
51
Grm.
Fol.1
Fol.2
Nr. Cls.
E. Cl.
T P.
Nr. Cls.1
Oocyte
E Nu.
Yolk
Cho.
F. Ep.
Pedicel
52
Pt. S.
Fol.1
Fol.2
F. Ep.
T. P.
Tr.
Ctx.
Mus.
53

number than those of a larger species (*Laphria gibbosa*), but that difference was not found between the largest species (*Proctacanthus*) and the smallest species (*Asilus*) included in this study. All ovarioles together with the egg calyx of each ovary are enclosed in a common peritoneal sheath which shows scattered nuclei and muscle fibers.

The ovarioles of an ovary are attached serially in an alternating arrangement to the calyx of the lateral oviduct. Each ovariole consists of three parts: the pedicel, the egg tube, and the germarium (Pl. VII, fig. 52). There is no thread-like terminal filament which is a condition not uncommon among Diptera (Keuchenius, 1917). The pedicel is a short, hollow stalk which attaches the ovariole to the calyx of the lateral oviduct. Until the first egg is laid, the pedicel is closed at its upper end next to the egg tube by a plug of epithelial cells. The egg tube is the main part of the ovariole and is made up of four or more distinct egg chambers each of which is separated from the next ones by distinct constrictions of the egg tube. The egg chamber just above the pedicel is much larger than the next, but thereafter the others gradually diminish in size toward the tip of the ovariole. The germarium, or end chamber, is the pointed end of the ovariole beyond the last egg chamber. It contains primary oogonia.

Surrounding each ovariole is a thin, structureless membrane, the tunica propria. Each of the more mature egg chambers is lined by a follicular epithelium consisting of small columnar cells, but this follicular epithelium has not been formed in the more distal and more immature egg chambers, which contain undifferentiated cells and are surrounded only by the tunica propria.

The ovarioles of the asilids are of the polytrophic type which is the condition to be found in all Diptera according to Gross (1903). In the asilids the nutritive cells and oocytes occur together in the same chamber and are surrounded by the same follicular epithelium.

Oviducts.—(Pl. VII, figs. 50, 51, and 53). The egg calyces are modified anterior extensions of the lateral oviducts. They are long in asilids and lie on the ventral side of each ovary. Back of the ovaries the oviducts continue for a short distance and then unite with the common oviduct which leads to the vagina. The common oviduct and lateral oviducts are alike in histological structure. The oviduct wall is composed of a low epithelial layer which is much folded except when an egg is passing through that part of the oviduct. The epithelium is lined with a thin intima. The musculature consists of an internal layer of small, closely set, longitudinal fibers surrounded by a thin layer of circular fibers. The egg calyces show very much the same musculature as the remainder of the oviducts except that the circular muscles appear reduced.

Spermathecae.—The spermathecae, or sperm receptacles, have a certain basic structure in asilids, but as to form there is a great variation among the species. All consist primarily of chitinous lined sacs or tubes which contain the stored sperms. They open into the dorsal region of the vagina by chitin lined ducts.

The spermathecae of *Asilus* and *Promachus* are similar to those of *Dasypogon cinctus* Meig. and *Dioctria rufipes* as drawn and described by Loew (1841), and to those of the species named above which Dufour

(1851) described. Sturtevant (1925–26) found similar spermathecae in *Atomosia* sp. and in *Dasyllis* sp., and Reichardt (1929) described the spermatheca as being three branched in *Machimus atricapillus*, *Asilus trifarius*, and *Laphria flava*. The spermathecae of *Asilus* and *Promachus* are three long tubes with their tapered ends coiled together in a compact mass (Pl. VIII, figs. 54, 55, 60 and 61). All three of the spermathecae are enclosed in a common peritoneal membrane. There is no distinct division into a receptacle and a duct, but internally the chitinous intima becomes thicker, narrowing the lumen, toward the proximal end. The stratified intima is brightly colored and shows through the other layers giving the spermatheca a pinkish or yellowish iridescence. The sperm form a compact mass in the lumen (Pl. VIII, figs. 56 and 65).

The epithelium of the spermathecae is composed of cylindrical cells and is glandular in nature. Each cell contains a large rounded vacuole which stains quite uniformly and appears to be demarked from the remainder of the cytoplasm by a membrane. Reichardt (1929) found these vacuoles communicating with the lumen through minute chitinous tubules, and the chitinous lining of the spermathecae has been described as having minute pores in other Diptera (Keuchenius, 1917). In *Promachus* pigment granules are present in the inner ends of the cells next to the chitinous lining. This pigmentation is evidently responsible in part for the pinkish color, but these pigment granules were not found in *Asilus* in which the spermathecae have a more yellowish tinge.

Each spermatheca in *Promachus* is surrounded by muscular fibers which go very nearly to the distal end. These muscles are very small, but are quite distinct and consist of closely arranged longitudinal fibers with infrequent circular fibers. These muscles were not found in *Asilus*.

In *Proctacanthus* the spermathecae are two ovoid bodies (Pl. VII, fig. 50). Sturtevant (1925–26) also found only two spermathecae in *Proctacanthus* sp., but he thought there were probably three present and that he had missed the third one in his dissection. The chitinous capsule is dark brown and shows through the thin covering of epithelium and peritoneal membrane. The epithelium is composed of higher cells at the proximal end and is thus less transparent giving the spermatheca the appearance as described by Tullock (1906) for *Stomxys* of "resembling the fitting of an acorn cup."

The proximal part (i. e., next to the vagina) of the spermathecal duct is a straight tube larger in diameter than the convoluted distal part (Pl. VII, fig. 50). The proximal part ends anteriorly in a blind pouch which appears as a knob-like enlargement externally, and the distal part opens into the proximal part below the pouch. The proximal part of the duct has a columnar epithelium of small cells lined internally by a thick, stratified intima and surrounded by several layers of cells which are all evidently muscles although they are indistinctly striated (Pl. VIII, fig. 62). These muscles are principally circular in arrangement, but there are scattered longitudinal fibers which lie for the most part near the epithelium. The pouch may serve as a glandular structure or it may function as a sperm pump since it is surrounded by the same musculature and has the same histological structure as the remainder of the proximal part (Pl. VIII, fig. 64). For a very short distance above the

pouch the distal part of the duct is surrounded by muscle fibers, but the remainder is surrounded only by a peritoneal membrane (Pl. VIII, fig. 63). This part of the duct is quite similar to the spermathecae of *Asilus* and *Promachus* in having a glandular epithelium showing vacuoles of secretion, but neither the epithelium of the proximal part of the duct, nor that of the spermathecae shows these vacuoles (Pl. VIII, fig. 66).

In *Erax* there are three spermathecae similar in structure to those of *Proctacanthus*, but they are more elongate with pointed distal ends (Pl. VIII, figs. 57 and 58). The ducts are filiform and throughout their length they are comparable in histological structure to the distal part of those of *Proctacanthus*.

Accessory glands.—One pair of accessory glands is found in all species. These are slender, tubular glands which open into the dorsal region of the vagina a short distance behind the openings of the spermathecal ducts.

The accessory glands of *Promachus* are long with several loops (Pl. VIII, fig. 54). Near their proximal end each is slightly swollen and has a transparent yellowish appearance. Behind this swollen portion there is an abrupt narrowing into a smaller duct. The accessory glands of *Asilus*, *Erax*, and *Proctacanthus* are considerably shorter than those of *Promachus*, and in these the glands are larger at their free ends and gradually diminish in diameter to their point of attachment (Pl. VII, fig. 50, and Pl. VIII, figs. 57 and 60).

The accessory glands of all the species have the same sort of structure (Pl. VIII, fig. 59). The epithelium is composed of rounded cuboidal cells covered on the outside by a peritoneal membrane and lined internally with a thin chitinous intima. The lumen is filled with a material which sometimes appears reticulated and sometimes solid. In the latter appearance it has a close resemblance to chitin. No muscles were found on the accessory glands.

INTERNAL MALE ORGANS OF REPRODUCTION

Dufour (1851) described and illustrated the gross anatomy of the male reproductive organs of three species of Asilidae: *Asilus crabroniformis* T., *Dasypogon teutonus* F., and *Laphria fulva* Meig. He found that the testes of *Laphria* do not resemble externally those of the other

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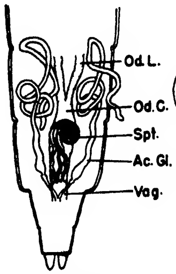
EXPLANATION OF PLATE VIII

FIG. 54. *Promachus*, spermathecae and accessory glands. 55. *Promachus*, single spermatheca. 56. *Promachus*, cross section of spermatheca below coiled portion. Camera lucida. 57. *Erax*, spermathecae and accessory glands. 58. *Erax*, single spermatheca. 59. *Erax*, cross section of female accessory gland. 60. *Asilus*, spermathecae and accessory glands. 61. *Asilus*, single spermatheca. 62. *Proctacanthus*, cross section of spermathecal duct from portion next to the vagina. 63. *Proctacanthus*, cross section of spermathecal duct from portion next to the spermatheca. Camera lucida. 64. *Proctacanthus*, longitudinal section of spermathecal duct in region of enlargement. 65. *Asilus*, cross section of spermathecae in coiled portion. Camera lucida. 66. *Proctacanthus*, wall of spermatheca. Camera lucida. *Ac. Gl.*, accessory gland; *B. M.*, basement membrane; *C. M.*, circular muscle; *Ep.*, epithelium; *Int.*, intima; *L. M.*, longitudinal muscle; *Od. C.*, common oviduct; *Od. L.*, lateral oviduct; *Pt. M.*, peritoneal membrane; *Sec.*, secretion; *Spt.*, spermatheca; *Spt. D.*, spermathecal duct; *Spz.*, spermatozoa; *Vag.*, vagina.



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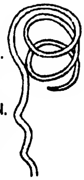

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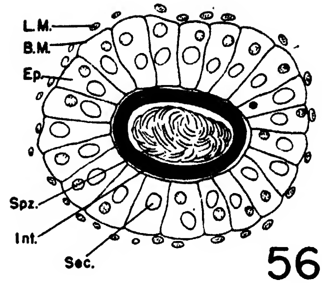

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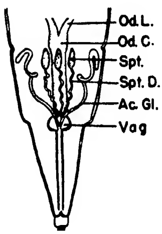

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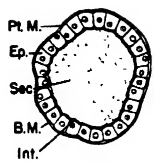

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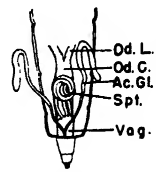

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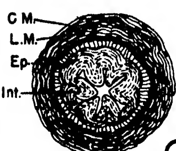

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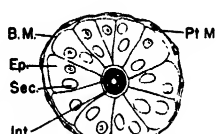

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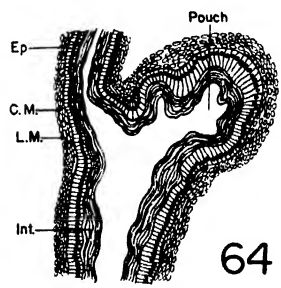

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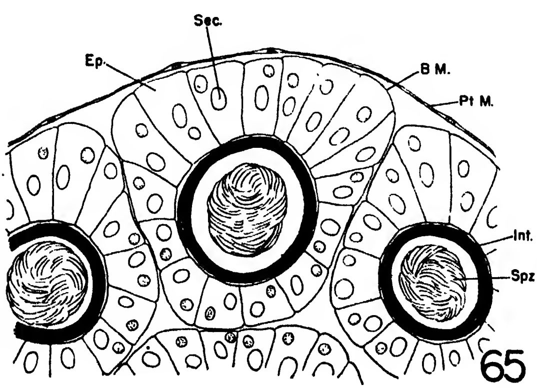

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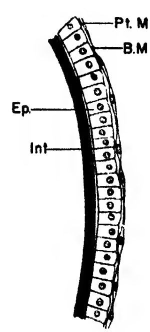

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two species in that they are covered by a common, scrotum-like structure, but that inside this covering the two testes were coiled as in the other species. He termed the accessory glands as seminal vesicles, but otherwise his drawings and descriptions fit very closely the similar organs of the species included in this study. Cholodkovsky (1892) described spermatogenesis and the histology of the internal male organs of the genus *Laphria*. He later (Cholodkovsky, 1905) made a comparative study of the testes of Diptera in which he included studies on three species of *Laphria* and several species of *Asilus*. His works confirm Dufour's descriptions of the unusual scrotum of *Laphria*. Reichardt (1929) described the internal male organs of the same three species named above for which he described the female organs.

In Asilidae the internal male organs of reproduction consist of four kinds of organs: the testes, the vasa deferentia, the ejaculatory duct, and the accessory glands.

Testes.—(Pl. IX, figs. 67 and 68). The testes are a pair of long, nearly filiform, tubular organs compactly coiled in a spiral fashion in the last few abdominal segments beside and below the rectum. Each testis uncoiled is approximately as long as the body length. The testes are conspicuous organs because of the pigmented sheath which invests them. This sheath is bright red in *Erax*, *Proctacanthus*, and *Promachus*, but in *Asilus* it is yellowish brown. The amount of pigmentation varies with individuals and appears to become more intense with age. The free ends of the testes are rounded, somewhat swollen, and extend forward for a short distance beyond the compact coils; this swollen free end is generally more lightly pigmented than the remainder of the testis. The testes are well supplied with tracheae and are enclosed in layers of fat tissue. There are no suspensory ligaments, but they are held in position by the tracheae and fat tissue.

Two layers make up the wall of the testis. These have been designated by Keuchenius (1913) the tunica externa and the tunica propria. The tunica externa contains scattered nuclei and is the layer which contains the pigment granules that give the testes their vivid coloring. Although the basement membrane can be seen quite clearly in some sections, the pigment granules generally do not have the appearance of being limited by a membrane. The tunica externa is somewhat loosely connected with the underneath layer from which it is easily separable. In fact, when there is a great amount of fat present in preserved spec-

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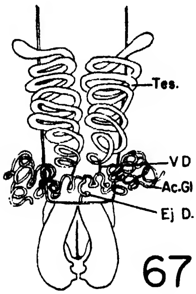
EXPLANATION OF PLATE IX

FIG. 67. *Promachus*, male reproductive organs. 68. *Proctacanthus*, male reproductive organs. 69. *Asilus*, cross section of male accessory gland. Camera lucida. 70. *Promachus*, cross section of testis in region of apical cell. 71. *Erax*, cross section of ejaculatory duct. Camera lucida. 72. *Erax*, cross section of testis in region of spermatids. Camera lucida. 73, 74, 75. *Proctacanthus*, cross sections of male accessory gland. 76. *Proctacanthus*, cross section of testis in region of spermatocysts. Camera lucida. 77. *Promachus*, cross section of testis in region of mergence into vas deferens. Camera lucida. *Ac. Gl.*, accessory gland; *B. M.*, basement membrane; *Cy. Cls.*, cyst cells; *Ej. D.*, ejaculatory duct; *Ep.*, epithelium; *Int.*, intima; *Mus.*, muscular layer (?); *Nu. Cl.*, nutritive cell; *Pt. M.*, peritoneal membrane; *Spds.*, spermatids; *Spg.*, spermatogonium; *Spz.*, spermatozoa; *T. E.*, tunica externa; *Tes.*, testis; *T. P.*, tunica propria; *V. D.*, vas deferens.



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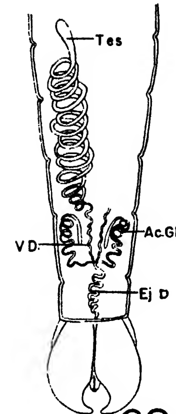

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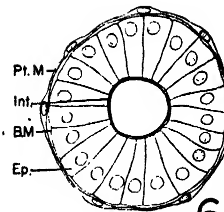

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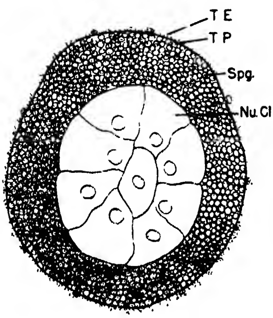

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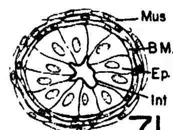

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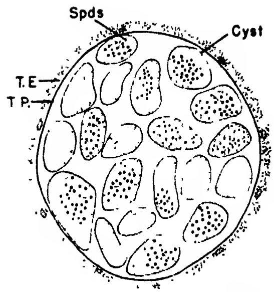

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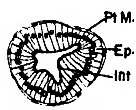

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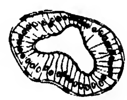

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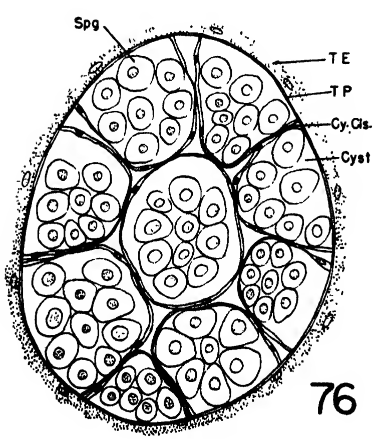

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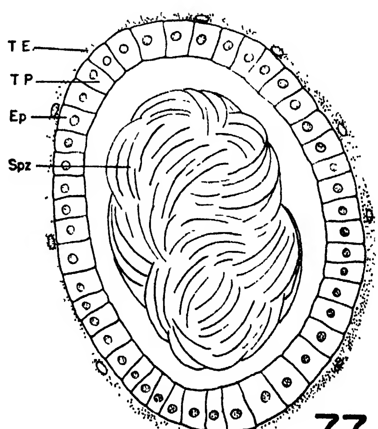

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imens, it is difficult to remove the testis without this layer adhering to the fat tissue.

The inner layer, or tunica propria, varies in structure from the anterior to the posterior end. In the anterior end and throughout most of the extent of the testis the tunica propria is a thin sheath without apparent cellular structure, but in the posterior part of the testis where it is merging into the vas deferens the tunica propria becomes an epithelial layer with definite nucleated cells (Pl. IX, fig. 77).

The testes of asilids are of particular interest to the study of spermatogenesis because of the presence of an apical cell in the adult stage. This apical cell is a large spermatogonial region in the swollen distal end of the testis. This region consists of a central group of giant nutritive cells surrounded by spermatogonia (Pl. IX, fig. 70). Verson (1889) described such a cell in the immatures of Lepidoptera (***Bombyx mori*** in particular), and in the Lepidoptera, as well as other orders, it has been termed the Versonian, or Verson's cell. Cholodkovsky (1892) in working with the genus *Laphria* found this same region in the adult stage of this robber fly. He and Grundberg later termed this group of cells as the apical cell, as he stated in a later paper (1905) on the testes of Diptera. In this later paper Cholodkovsky described the apical cell as it occurs in three species of *Laphria* and in *Asilus* sp. He says the testes of asilids serve as excellent objects for the study of spermatogenesis since all the stages of spermatogenesis can be found in the testis of the adult. Metz and Nonidez have studied spermatogenesis in the Asilidae and they say (1923) that the early growth stages of the spermatocyte are represented in an unusually clear-cut fashion and that all the successive stages of spermatogenesis from spermatogonia to spermatozoa are represented in serial order down the long testis of a single specimen. (For references to their other papers see Metz and Nonidez, 1924).

Immediately behind the apical cell is a region of spermatogonia and behind these the spermatogonia are enclosed in a sperm cyst (Pl. IX, fig. 76). Then down the long testis are successive regions of spermatocytes, spermatids, and spermatozoa. The cyst cells have degenerated in the region of the spermatids (Pl. IX, fig. 72), and have disappeared in the region of the spermatozoa, but the spermatozoa of each cyst still remain collected together into distinct bundles. Each bundle consists of numerous spermatozoa lying lengthwise in the testis with their heads oriented toward the distal end of the testis.

Vasa deferentia.—The vasa deferentia are not distinctly separate organs in the asilids but the last few coils of the testes may be considered as such. Hewitt (1914) in describing ***Musca domestica*** says that the pointed end of each testis is continued as a fine vas deferens. Minchin (1905) gives a somewhat similar description for *Glossina palpalis*. The vas deferens of asilids is considerably smaller in diameter and has less pigmentation than the testis. The vas deferens has the same layers of the wall as the testis (Pl. IX, fig. 77). The tunica externa is generally thinner and less pigmented than that of the testis, but the tunica propria is thicker and consists of a well-developed cuboidal epithelium. Cholodkovsky (1892) says that parietal epithelium is not present in the testis except in the region of transition into the vas deferens where the epithelium is at first low and then gradually becomes higher. There is no muscular layer on the vas deferens.

The two vasa deferentia and the two accessory glands connect with the ejaculatory duct at the same point in *Asilus*, *Erax*, and *Proctacanthus* (Pl. IX, fig. 68), but in *Promachus* each vas deferens opens into the corresponding accessory gland some distance from their union with the ejaculatory duct (Pl. IX, fig. 67), or it might be that the ejaculatory duct is bifurcate at its distal end and that each fork extends to the opening of the vas deferens of that side. Snodgrass (1935) states that the anterior end of the ejaculatory duct is frequently forked, especially when there are accessory glands which arise from it.

Ejaculatory duct.—The ejaculatory duct, since it receives the openings of the vasa deferentia and accessory glands and leads into the adeagus, serves as the common exit duct for all the internal male organs. It is a short tube with one or a few loops and is small in diameter. In several species of Diptera the ejaculatory duct has been described as crossing the rectum dorsally, but in the asilids included in this study it was found below the rectum in every case.

The epithelium is made up of columnar cells of varying heights resting on a basement membrane (Pl. IX, fig. 71). This is lined internally with a thick chitinous intima. The lumen may be variously shaped and narrowed with the different species and with different sections of the same individual. External to the epithelium there is a thick coating of cells containing nuclei. They are arranged like circular muscles and perhaps are such, but no striations could be seen in them. Cholodkovsky (1892) considered this coating as a thick stratified membrane in *Laphria*, and Reichardt (1929) described a thick, connective tissue membrane surrounding the epithelium.

Accessory glands.—(Pl. IX, figs. 67 and 68). The male accessory glands are a pair of small greatly coiled tubes that are filiform throughout their length. Each lies beside and partially below the last several coils of the testis of that side.

The epithelium of the accessory glands is composed of columnar cells resting on a basement membrane (Pl. IX, fig. 69). In most cases the epithelial cells are rather uniform in height and with their nuclei located near the outer ends, but they may vary in height and the lumen of the tubes may be irregularly shaped as in *Proctacanthus* (Pl. IX, fig. 73–75). Cholodkovsky (1892) stated that these epithelial cells are here and there higher and form a large number of prominent, longitudinally elevated glands in the lumen. A thin intima lines the epithelium, but it is generally very difficult to distinguish. Reichardt (1929) found no intima in the male accessory glands. There is a thick nucleated peritoneal sheath surrounding the accessory glands of *Erax*, *Proctacanthus*, and *Promachus*, but in *Asilus* there is a thinner peritoneal membrane. No muscular fibers were found on the accessory glands.

ORGANS OF CIRCULATION

The organs of circulation consist of the dorsal vessel and the diaphragms. The dorsal vessel is made up of two distinct parts, the heart lying wholly in the abdomen and the aorta beginning in the abdomen and extending into the head. Both dorsal and ventral diaphragms are present. In connection with the organs of circulation the pericardial cells and the corpus allatum will be briefly described.

Heart.—(Pl. X, fig. 78). The heart lies in the mid-dorsal line of the abdomen between the body wall and the dorsal diaphragm. The heart is supported as in other insects by the dorsal diaphragm with its alary muscles. The heart is connected to the dorsal diaphragm below and the body wall above by delicate fibrillar extensions of its wall (Pl. XI, fig. 87), which Popovici-Baznosanu (1905) described as being elastic in nature. Surrounding the heart are numerous pericardial and fat cells. Tracheae extending across the heart are found in each abdominal segment.

The heart is a slightly flattened, tubular organ extending from the first to the eighth (last visible dorsal segment of males) abdominal segment where it ends in a closed tapered point. The heart does not show distinct chambers, but in each segment there is a slight enlargement into which the ostia open. There are no interventricular valves as have been described for some Diptera (Brown, 1910, and others).

The wall of the heart is a muscular layer lined internally with a very delicate membrane and covered externally with a slightly thicker membrane. These membranes are difficult to distinguish in a cross section (Pl. XI, fig. 85), but in a longitudinal section they can be seen enclosing the muscular bands between them (Pl. X, fig. 79). Graber (1873) termed the outer membrane "adventitia" and the inner one "intima." The muscle fibers are arranged in broad flat bands that run spirally around the heart. Newport (1839) in describing the heart of *Asilus crabroniformis* observed "the fibers of the heart crossing each other in an oblique direction," and others have since given a similar description of crossing fibers in the heart. Because of the transparency of the heart these muscle bands appear to cross each other in an interlacing fashion, but when studied more closely it can be seen that the bands in the dorsal wall are all going in one direction while those of the ventral wall are all going in a crossing direction (Pl. XI, fig. 86). Definite cell endings have been found in the heart of other insects (Zawarzin, 1911; and Wettinger, 1927), but in the asilids endings of the muscle bands could not be seen except in the region of transition between the heart and the aorta. The spiral arrangement is continuous throughout the length of the heart even to the short, tapered posterior part behind the eighth pair of ostia. The nuclei of the muscle fibers are regularly spaced down each side, with the nuclei of one side belonging to the dorsal bands and those of the other to the ventral bands of fibers. The nuclei are very large and show two regions, an outer clear area and an inner area containing the chromatin material (Pl. XI, fig. 85).

The ostia are paired slit-like openings occurring in each segment, or a total of eight pairs. The last pair occur almost at the end of the

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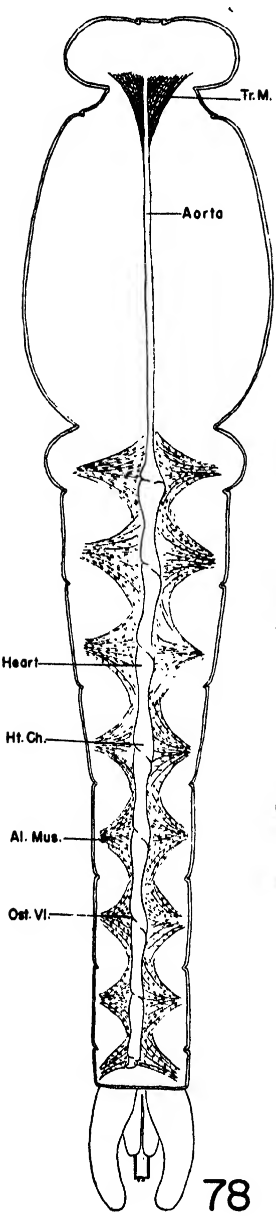
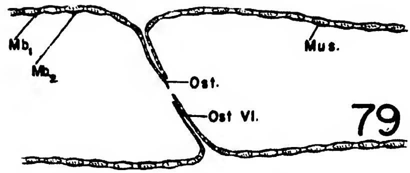
EXPLANATION OF PLATE X

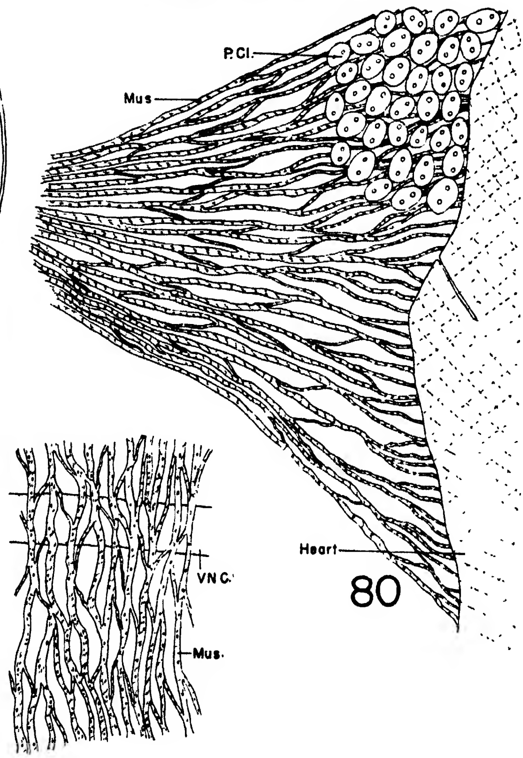
FIG. 78. *Proctacanthus*, dorsal vessel. 79. *Proctacanthus*, longitudinal section of heart through a pair of ostial valves. 80. *Proctacanthus*, group of alary muscles, most of pericardial cells removed. 81. *Proctacanthus*, portion of ventral diaphragm. 82. *Proctacanthus*, longitudinal section of corpus allatum. Camera lucida. *Al. Mus.*, alary muscle; *Ht. Ch.*, heart chamber; $Mb._1$, membrane covering heart; $Mb._2$, membrane lining heart; *Mus.*, muscle fiber; *Ost.*, ostium; *Ost. Vl.*, ostial valve; *P. Cl.*, pericardial cell; *Tr. M.*, tracheal membrane; *V. N. C.*, ventral nerve cord.


Tr. M.
Aorta
Heart
Ht. Ch.
Al. Mus.
Ost. VI.

78


Mb1
Mb2
Mus.
Ost.
Ost VI.

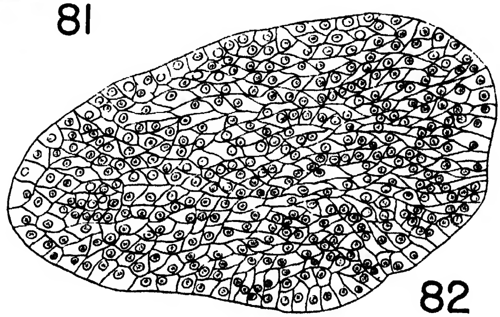
79


P. Cl.
Mus
Heart

80

VNC.
Mus.

81



82

heart. The ostia do not occur exactly opposite each other, but those of one side are slightly in front of their mates on the other. The muscle cells on each side of the ostia are modified and have smaller nuclei than the other cells. These nuclei are placed near the inner opening of the ostia (Pl. XI, fig. 86). No internal ligmants were found connected with the ostial valves.

The first chamber of the heart is more expanded than the others and in it the ostia appear very nearly opposite each other. This first pair of ostial valves are larger than the succeeding ones. The width of this first chamber varies with the species and is especially expanded in *Promachus* (Pl. XI, fig. 83).

Anterior to the ostia of the first abdominal segment there is a transition region between the heart and the aorta in which the heart becomes gradually narrowed (Pl. XI, fig. 83).

Aorta.—The aorta begins in the first abdominal segment and runs forward as a narrow and uniform tube through the thorax and neck into the head where it becomes slightly narrowed and appears to end behind the brain. There is no dorsal membrane nor alary muscles supporting the aorta, but it lies on the dorsal side of the thoracic stomach and oesophagus to which it is rather firmly attached. There are no ostia in the aorta.

The muscle fibers of the aorta present an unusual appearance. With casual observation the fibers appear to radiate out from the large nuclei, but although the arrangement is not so obvious as in the heart, the fibers have a loose spiral arrangement which is shown diagrammatically in Fig. 84, Pl. XI. The nuclei have an alternate arrangement and the fibers in passing over them are more compactly grouped becoming separated in between successive nuclei.

Diaphragms and sinuses. The dorsal diaphragm is composed of a thin membrane supported by small muscles, the alary muscles, arranged in eight pairs (Pl. X, fig. 78). A group of alary muscles is attached to the tergum of each abdominal segment on each side of the body. They are larger at their point of attachment becoming separated into smaller fibers toward the heart as they spread out fanwise into the membrane (Pl. X, fig. 80). The dorsal diaphragm incompletely shuts off the dorsal, or pericardial, sinus from the visceral sinus, but the semi-circular openings between successive groups of alary muscles allow free circulation between the two sinuses.

Numerous pericardial cells and fat cells are found in the pericardial sinus (Pl. XI, fig. 87). The pericardial cells lie on the dorsal membrane in wide groups on each side of the heart. The pericardial cells are large oval cells each of which generally contains two nuclei which are well

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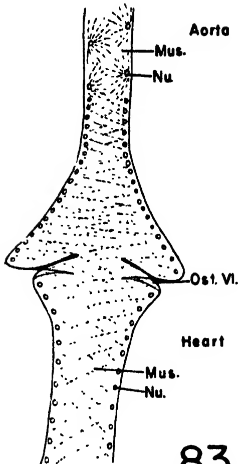
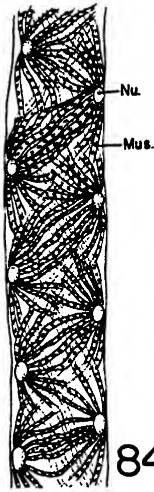
EXPLANATION OF PLATE XI

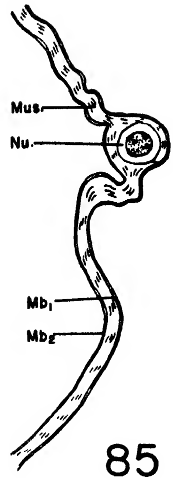
FIG. 83. *Promachus*, first heart chamber with part of aorta. 84. *Proctacanthus*, portion of aorta. 85. *Proctacanthus*, wall of heart. Camera lucida. 86. *Proctacanthus*, portion of heart with part of dorsal wall removed to show the ventral wall. 87. *Proctacanthus*, cross section of heart and dorsal diaphragm. *D. M.*, dorsal membrane; *Fb.*, fibrillar extension of heart wall; *F. Cls.*, fat cells; *M. B.*$_1$, membrane covering heart; *M. B.*$_2$, membrane lining heart; *Mus.*, muscle; *Mus. Vl.*, muscle of ostial valve; *Nu.*, nucleus; *Nu. Vl.*, nucleus of valvular muscle; *Ost. Vl.*, ostial valve; *P. Cl.*, pericardial cell.


Aorta
Mus.
Nu.
Ost. Vl.
Heart
Mus.
Nu.

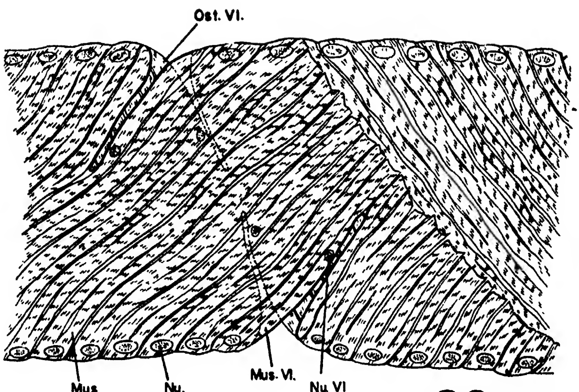
83


Nu.
Mus.

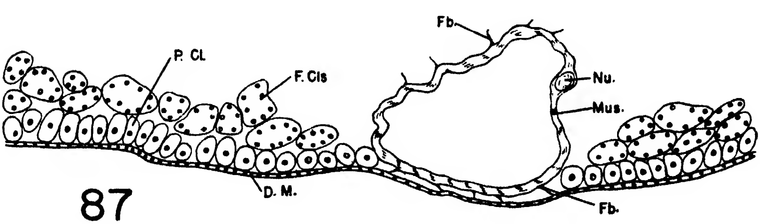
84


Mus.
Nu.
Mb1
Mb2

85


Ost. Vl.
Mus
Nu.
Mus. Vl.
Nu. Vl

86


P. CL
F. Cls
Fb.
Nu.
Mus.
D. M.
Fb.

87

separated (Pl. X, fig. 80). They generally lie with their long axis parallel to the heart so that in a cross section only one nucleus appears. Hollande (1922) says that they have a merocrine secretion and that they neutralize the excess alkalinity of the blood as well as aiding in the excretion of albuminoids.

The ventral diaphragm is similar in structure to the dorsal diaphragm except that the muscle fibers are smaller and are more nearly parallel in arrangement (Pl. X, fig. 81). It lies just above the ventral nerve cord and is a more or less continuous sheet throughout the abdomen. It shuts off the ventral, or perineural sinus, from the visceral sinus. In addition to the nerve cord the ventral sinus contains large masses of fat tissue.

Corpus allatum.—A single corpus allatum is attached to the dorsal side of the aorta between the salivary glands in the most anterior part of the thorax. It is a compact cellular mass which is ellipsoidal in form (Pl. X, fig. 82). The cells on the periphery are larger and have more distinct cell walls than those in the center of the body. The cells are enclosed by a thin membrane. The fact that there is a single corpus allatum is of some interest in that Nabert (1913) found, as in most insects, paired corpora allata in *Tipula* which was the only species of Diptera described by him. Minchin (1905) described a cushion-like mass of cells lying above the aorta of *Glossina* which he thought was some sort of lymphatic gland, but this was perhaps a single corpus allatum. A single corpus allatum has been described for three other flies (Day, 1934).

The corpora allata have been variously named in literature (Wettinger, 1927), and various functions have been ascribed to them. Day (1943) says that the corpus allatum has some influence on the metabolism of the insect and that many tissues are affected by it. Zee and Pai (1944) say that the corpora allata are holocrine in secretion and that they are no longer traceable in the adult. What is here described as a corpus allatum would probably be the corpus cardiacum as described by them.

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This volume is devoted principally to a catalogue of the fishes of Chile by Henry W. Fowler, but among other articles includes several on insects. These are: Contribuciones al Conocimiento de los Scarabaeidae Chilenos, la Tribu Liparentrini (Melolonthinae), by Ramon Gutierrez; Consideraciones Zoogeograficas de los Midasideos Chilenos, by Rodolpho Wagenknecht Huss; Observaciones sobre la Biologia del "Gusano de los Penachos" Notholophus (*Orgyia*) Antiqua L. en Chile, by Hector Pairoa Epple; Un Predator de Importancia que Frecuentemente se Olvida. *Coccinella ancoralis* Germ. (*Col. Coccinellidae*), by Juan M. Borg; Apidologia Chilena, Segunda Parte, Subfamily Colletinae, by Flaminio Ruiz Pereira; Sobre la Importancia Economica de las Especies Chilenas del Genero Dichroplus Stål (Orth. Acrid. Cyrtacanth). con Algunas Consideraciones Acerca de su Biogeografia, by Jose Liebermann and Ropalaceros de Satipo (Peru) by Emilio Ureta, which is only a list of species.—A. W. L.

THE LARVAE OF THE GENUS NOSODENDRON LATR.

(Coleoptera, Nosodendridae)

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The genus *Nosodendron* Latr. (*Dendrodipnis* Woll.) is found widespread over the world. Lucas (1920) in his Catalogus Coleoptorum gives the distribution as Europe, Japan, Sumatra, New Guinea, New Zealand and the Americas. Only two species have been described from North America and one from Europe. The genus was formerly placed in the family Byrrhidae (Pill Beetles) but in recent years has been considered as a separate family, Nosodendridae.

The adult beetles have been taken under bark and around the flowing sap of old elm and alder trees and the larvae are usually found in the same places with the beetles. Blatchley (1910, p. 672) records the occurrence of *N. unicolor* adults in Indiana from April 22 to July 4. The adults of *N. californicum* (fig. 15) are small rounded-oval, strongly convex beetles about five mm. long. They are black, somewhat shining and rather densely and coarsely punctate. Larvae of this genus are thought to be predators on dipterous larvae.

The larva of the only European species *N. fasciculare* Ol. was early described by Chapuis and Candèze (1853) and later a better and more exact description was published by Dufour (1862). Laboulbène (1862) concerned himself with a discussion of the spiracles of the larva but failed to describe the eighth or terminal spiracle. He mistakenly thought that the two large tubercles located dorsally near the base of the terminal segment were spiracles. Ganglbauer (1904, Vol. 4, pt. 1, p. 89–90) has given us our most recent description of this European larvae and adult although Kuhnt (1913, p. 1124) has more recently figured the larvae of this species.

Our two American species, *N. unicolor* Say found in the eastern states, and *N. californicum* Horn from the western states, have not been described in the larval stage although Böving and Craighead (1931, pl. 66) have illustrated some of their morphological characteristics but have not described them. The pupae have not been described for any species as far as the authors are aware, and no specimens are available in the U. S. National Museum Collection.

Larvae of *N. unicolor*, believed to be nearly full grown, in possession of the writers, were collected in fungi on a dying elm tree, June 16, 1939, at Urbana, Illinois. A single specimen in the Illinois State Natural History Survey Collection was taken at Chicago, Illinois, in "old *Cossus* borings in Silver Leafed Poplar" by E. G. Titus, September 20, 1901. Through the kindness of Dr. C. F. W. Muesebeck of the Insect Division of the U. S. Bureau of Entomology the specimens of *N. unicolor* and *N. californicum* present in the U. S. National Museum

*Contribution No. 246 from the Entomological Laboratories of the University of Illinois.

Collection were loaned to the writers for this study. In this material the following specimens were available:

N. unicolor.—One larvae in sap oozing from willow "Victoria Jx," April 11, 1913, J. D. Mitchell Coll. Det. R. A. St. George; five larvae labeled *Nosodendron sp.* from "Hubbard No. 573," no date; seven larvae labeled *Nosodendron sp.* from sap of elm, Detroit, Michigan, 187, "Hubbard 559"; four larvae labeled *Nosodendron* sp. No. 2201 box 10, div. 3, Michigan? These unidentified specimens are all *N. unicolor.*

N. californicum.—Four larvae and one adult from sap at wound on white fir, May 10, 1915, Ashland, Oregon, H. G. Champion; one larva and two adults with no data.

Since no description of larvae of our American species exists, it is thought desirable to describe the larva of *N. unicolor* and make comparisons with *N. californicum* and with the better known European *N. fasciculare.*

Nosodendron unicolor Say

Larval Size and Number of Instars.—Nothing is known of the life history of the species of *Nosodendron.* The writers have been unable to find any mention in the literature of any recorded rearings. Therefore, one is only able to speculate as to the number of instars. Most of the larvae available are apparently full grown. These have a body length varying from 9.5 to 10.2 mm., with a head width of 2–2.1 mm. Among specimens received from the U. S. National Museum there are larvae of five different sizes. Each of these apparently represent a different instar, making at least five instars. The body length and width of head of the various instars are found in the following tabulation:

TABLE I

Size of Larval Instars in *N. Unicolor*

Instar	Body Length in mm.	Head Width in mm.
First	3.	0.7
Second	4.8	1.1–1.2
Third	5.5	1.55
Fourth	8.5	1.80
Fifth	9.5–10.2	2.–2.1

The principal differences in the various instars seem to be in the matter of punctation and the position of the spiracles. The first instar has the head and prothorax less strongly punctured than the other body segments but this difference is not noticeable in the second instar. It is difficult to determine the presence of ocelli in the first and second instars, although they are present, but they are quite evident in the third and later instars. The first instar larva apparently has but two pairs of functional spiracles. There is only one dorsal pair on the first abdominal segment and one pair on the distal end of the last abdominal spiracle.

The Head.—Dorsal Aspect. The head (fig. 12) is much wider than

long. It is densely covered with minute, brown tubercles (fig. 5) which, under high magnification, seem to be provided with a clear central area. The entire surface of each tubercle is covered with minute spinulae. Near the meson and caudally the tubercles are arranged in a reticulated network enclosing a number of smooth circular areas.

There is an epicranial suture (ES) that lacks the epicranial stem. Near the anterior-lateral margin of the head are located five *ocelli* (OC). They are clear, colorless and raised slightly above the surrounding surface. The anterior ocellus is far enough laterad to be seen from the ventral surface and is just behind the base of the antenna. The others are more dorsally and caudally located and arranged in a subquadrate group. Because of their clear coloration they may be easily overlooked and are difficult to see in the early instars.

The front and clypeus (FC) are fused into a single area by the absence of a fronto-clypeal suture. A clypeo-labral suture (CS) separates the labrum from the rest of the head. The labrum (L) is trapezoidal in shape and about one-half as long as the width at the base. The cephalic margin is emarginate and the cephalic and lateral margins bear a fringe of long setae.

Ventral Aspect. Most of the ventral aspect of the head (fig. 13) is occupied by the maxillae (MX) and labium (LAB). The genae (G) are folded under the head to occupy the lateral regions. They are covered with the same cuticular nodules that are found on the dorsal aspect. Near the cephalo-lateral angle the anterior ocellus is to be seen. A curving longitudinal ridge on the gena extends caudo-laterally from the base of the mandibles to the back of the head and mesad of this ridge is a sloping area devoid of cuticular nodules. The ridge and mesal area are finely but densely setaceous. A membrance closes the area between the head and the labium.

Antennae. The antennae (fig. 12, ANT) are located dorsally on the cephalo-lateral margin of the head. They are considered by Böving and Craighead (1931) as being three-segmented although Ganglbauer (1904, p. 89) calls them four-segmented. A large basal area looking like a basal segment is here considered to be a part of the head capsule. This basal area is as wide as long and somewhat conical in shape. It is the part considered as an antennal segment by Ganglbauer but not by Böving and Craighead. The writers feel that this basal structure is definitely not an antennal segment. The first segment, therefore, is the short bead-like segment which is about as broad as long and about one-half the length of the basal area. It is setaceous distally. The second segment is long, cylindrical and nearly three times as long as the first. A minute, third segment is almost globular and bears several, small, sensory processes.

Labrum. The labrum (fig. 12, L) is roughly trapezoidal with its cephalic margin deeply emarginate and its latero-caudal angles extended into acute angles. Its cephalic margin bears a row of setae and the entire ectal surface is rather densely punctate.

Epipharynx. The distal margin of the labrum (fig. 22) is deeply excised. This margin bears a row of dense setae which are about one-half the length of the lateral tufts of setae on the thorax and abdomen. The lateral epipharyngeal area is membranous with several trans-

verse striated rows not quite reaching the lateral margin. The central area bears a chitinous Y-shaped sclerite that is non-setaceous.

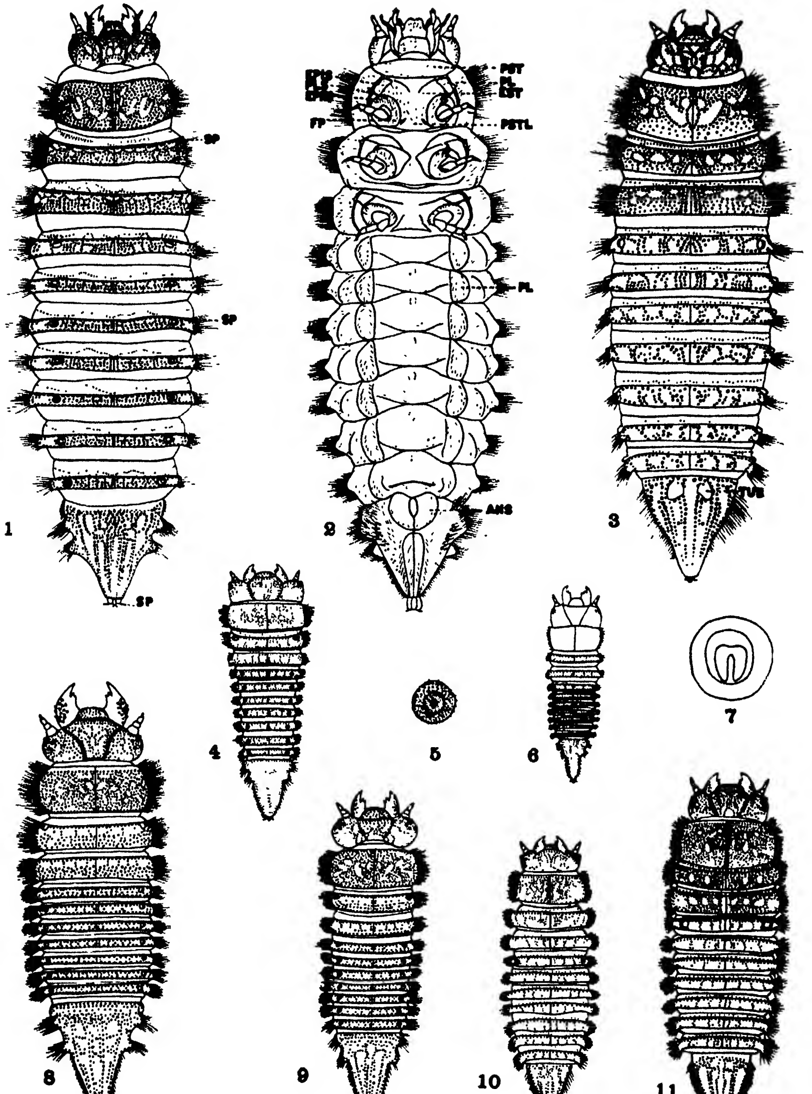
Mandibles. The two mandibles (fig. 14) are similar in shape and in dentation. They articulate with the head by three condyles. These have been termed by Böving and Craighead (1931) the ***dorsal condyle***, the ***ventral condyle*** (VC) and the ***accessory ventral condyle*** (ACV). The ***dorsal condyle*** is small and articulates with a small acetabulum on the head capsule located at the lateral ends of the clypeo-labral suture. The ***ventral condyle*** articulates in a socket on the gena just behind the antennae and the ***accessory ventral condyle*** likewise works on the genae somewhat farther caudad. The three condyles make up what is known as a tricondylic articulation.

The scrobe (SB) is covered with small tubercles. There is a single large terminal tooth and the scissorial area (SR) is provided with a two-toothed ***retinaculum*** (RT). The distal tooth of the retinaculum is wider and about twice the length of the basal one. The molar area (M) is not adapted for grinding. Its margin is broadly rounded and provided with a cluster of setae (brustia). Caudally, the molar area extends into a broad, thin area which bears the accessory ventral condyle. The caudo-mesal margin is provided with a brush of fine setae.

Maxillae. The ***cardo*** (fig. 17, CD) is triangular in shape and is apparently divided in two parts. A small, proximal, triangular area (SC) is often called the subcardo and a larger subquadrangular area is the so-called eucardo (EC). On the mesal margin of the two parts of the cardo is a membrane which attaches to the labium. This is the so-called labacoria of MacGillivray. The ***stipes*** (ST) is elongated and subrectangular. Its ventral aspect bears a longitudinal row of short setae. The ectal margin is enlarged somewhat to form a palpifer (PF)

LIST OF ABBREVIATIONS

ACV........accessory ventral condyle
ANS........anal segment
ANT.......antenna
CD.........cardo
CL.........claw
CS.........clypeolabral suture
CX.........coxa
EC.........eucardo
EPIM......epimeron
EPIS.......episternum
ES.........epicranial suture
EST........eusternum
FC.........frontoclypeus
FP.........furcal pit
FUR.......femur
G..........gena
GA.........galea
GL.........glossa
HS.........lateral sclerite of hypopharynx
HYP.......hypopharynx
HYP. BR..hypopharyngeal bracon
L..........labrum
LAB.......labium
LC.........lacinia
M..........molar area
MD........mandible
MP.........maxillary palpus
MT.........mentum
MX........maxilla
OC.........ocellus
PF.........palpifer
PGL........paraglossa
PL.........pleuron
PLS........pleural suture
PM.........prementum
PST........presternum
PSTL......poststernellum
RT.........retinaculum
SB.........scrobe
SC.........subcardo
SM.........submentum
SP.........spiracle
SR.........scissorial area
ST.........stipes
TR.........trachea
TRO.......trochanter
TT.........tibio-tarsus
TUB.......tubercle
VC.........ventral condyle



EXPLANATION OF PLATE I

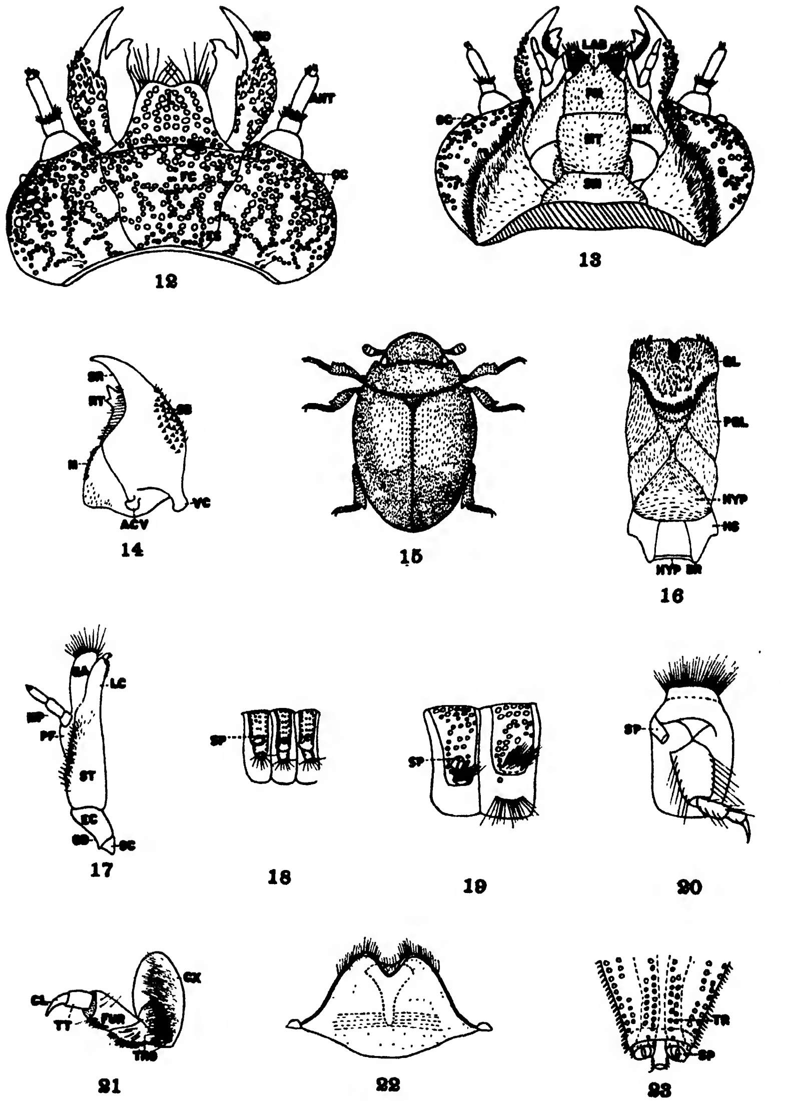
Fig. 1. *Nosodendron unicolor* Say, full-grown larva, dorsal aspect. Fig. 2. *Nosodendron unicolor* Say, full grown larva, ventral aspect. Fig. 3. *Nosodendron caulifornicum* Horn, full-grown larva, dorsal aspect. Fig. 4. *Nosodendron unicolor* Say, probable 2nd instar larva. Fig. 5. A tubercle on dorsum of *Nosodendron unicolor* Say. Fig. 6. *Nosodendron unicolor* Say, probable 1st instar larva. Fig. 7. An abdominal spiracle of *Nosodendron unicolor* Say. Fig. 8. *Nosodendron unicolor* Say, probable 4th instar larva. Fig. 9. *Nosodendron unicolor* Say, probable 3rd instar larva. Fig. 10. *Nosodensron californicum* Horn, intermediate instar. Fig. 11.*Nosodendron californicum* Horn, intermediate instar.

which bears a three-segmented maxillary palpus (MP). The first segment is small, being about as wide as long, the second is about twice the length of the first and somewhat enlarged distally. The third segment is about the length of the second and is somewhat pointed. It bears small, sensory structures on its distal end. The galea (GA) is shaped somewhat like a spatula with its distal end bearing a row of elongated setae. The lacinia (LC) does not seem to be separated from the stipes by a suture. It becomes gradually attenuated distally and its apex is terminated in two, small, claw-like hooks. A few very small setae occur on the mesal margin immediately proximad of the terminal hooks.

Labium. The labium (fig. 13, LAB) is composed of three main sclerites. The submentum (SM) is about twice as wide as long, somewhat trapezoidal and with its caudo-lateral angles prolonged. The mentum (MT) is roughly quadrangular with its lateral margins somewhat rounded. The prementum (PM) is a single piece with its sides parallel and its anterior margin tapering distally to form two small lobes which are separated by a small angulate emargination. The distal margin bears a number of rather large, yellowish setae.

Hypopharynx. The hypopharynx (fig. 16) located on the ental aspect of the labium, is a fleshy structure covered with sensory processes. The distal area, densely covered with setae and lying entad of the prementum, is regarded as the infolded glossae (GL). Caudolaterad of the glossa on each side is a faintly striated area, roughly triangular in outline, that is considered the *paraglossa* (PGL) by Böving and Craighead. Meso-caudad of the paraglossae is a single triangular area that is the hypopharynx proper (HYP). Under high magnification the glossa is seen to be finely striated. Caudad of the hypopharynx is a pair of lateral sclerites (HS) connected by a transverse bridge. These sclerites make up the hypopharngeal bracon (HYP.BR.) of Böving and Craighead or the suspensorial plates and apodemal process of Snodgrass (1935, p. 115).

Prothorax. The thorax (fig. 1) is the broadest part of the body. The *prothorax* on the dorsal surface is twice as long as either the meso- or metathorax. In width, the prothorax is about two times as wide as its length. Its dorsal surface is rather densely covered with the same small tubercles found on the head. These tubercles (fig. 5) are so spaced as to form a number of smooth, circular areas on the disk. On the anterior and posterior margins, the absence of tubercles produces a cephalic and caudal area that is quite smooth. The lateral margins each bear a row of rather long, yellowish setae. The prothoracic sternum is divided into three parts. A transversely narrow, cephalic area, the *presternum* (fig. 2, PST), overlaps the ventro-caudal area of the head. A second larger area, the *eusternum* (EST) is defined by Böving and Craighead as "the anterior sternal area in front of the suture between the furcal pits." In this species, the furcal pits (FP) are evident as small slits meso-caudad of the coxal cavities and no distinct suture separates the eusternum from the region caudad of the pits which is the *poststernellum* (PSTL). A narrow, inflexed pleuron (PL) is separated from the sternum by a longitudinal curved suture. The coxae are articulated to the pleuron by a small coxal condyle. From the condyle, a short pleural suture (PLS) extends cephalo-laterad



EXPLANATION OF PLATE II

Fig. 12. *Nosodendron unicolor* Say, dorsal aspect of head. Fig. 13. *Nosodendron unicolor* Say, ventral aspect of head. Fig. 14. *Nosodendron unicolor* Say, left mandible, ventral aspect. Fig. 15. *Nosodendron californicum* Horn, adult beetle. Fig. 16. *Nosodendron unicolor* Say, hypopharynx. Fig. 17. *Nosodendron unicolor* Say, right maxilla, ventral aspect. Fig. 18. *Nosodendron unicolor* Say, first three abdominal segments. Fig. 19. *Nosodendron californicum* Horn, first two abdominal segments. Fig. 20. *Nosodendron californicum* Horn, mesothorax. Fig. 21. *Nosodendron unicolor* Say, right prothoracic leg. Fig. 22. *Nosodendron unicolor* Say, epipharynx. Fig. 23. *Nosodendron unicolor* Say, last abdominal segment, ventral aspect.

toward the tergum dividing the pleuron into a small but distinct episternum (EPIS) and an epimeron (EPIM).

Mesothorax. The *mesothorax* (fig. 1) on the dorsal surface is about one-half the length of the prothorax. It differs from the other thoracic segments in having a pair of conspicuous round spiracles (SP). Each spiracle is raised on a small protuberance and located near the cephalo-lateral angle. The three, transverse annulets found on the prothorax are also found on the mesothorax but the anterior region is interspersed with small tubercles and a row of larger tubercles connecting the two spiracles separates the anterior annulet from the larger middle annulet which is densely covered with tubercles, a few of which are arranged to produce a few, smooth, circular areas. The caudal, transverse annulet is smooth as in the prothorax. The pleural and sternal areas are similar to those of the prothorax.

Metathorax. The *metathorax* differs little from the mesothorax. It does, however, lack the presence of a pair of spiracles. The lateral margins of both the meso- and metathorax bear rows of long, yellowish setae. The lateral margins are not tuberculated as they are in the abdominal segments.

Legs. (fig. 21). The three pairs of legs are about equal in length and made up of similar segments. The large *coxa* (CX) is moderately setaceous and has a row of larger setae near the distal end. The *trochanter* (TRO) is triangular from the lateral aspect and its margin is densely setaceous. The *femur* (FUR) is cylindrical and about twice as long as wide. It bears a row of dense setae on its margin. The *tibiotarsus* (TT) likewise is cylindrical and only slightly longer than wide. It is somewhat narrower than the femur and is separated from the claw (CL) by a distinct suture.

Abdomen. The first seven abdominal segments are similar. Each becomes slightly narrower than the preceding segment. Dorsally (fig. 1) each is divided into three transverse areas. The anterior annulet has a few sparsely placed tubercles with a tendency for most of them to be arranged in a transverse row. The middle annulet is narrower than the middle annulets of the thoracic segments and, like them, the tubercles have about the same density and some are arranged to form indistinct, smooth circular areas. The caudal annulet is narrow and without tubercles. The middle annulet in each of the first seven segments bears a pair of raised spiracles (SP). These are located a short distance from the lateral margins which bear a lateral protuberance that carries a tuft of long, yellow setae. The lateral margins of the cephalic and caudal annulets are without setae on the first seven segments. In available drawings of the European *N, fasciculare*, the dorsal abdominal tubercles appear to be arranged into six longitudinal rows of setae.

On the ventral aspect (fig. 2) the first seven abdominal segments are similar. An inflexed portion of the tergum is separated from a narrow pleuron (PL) by a longitudinal suture and the pleuron is in turn separated from the single sclerite sternum by another longitudinal suture. Each sterna of segments two to seven has on the mid-ventral line, a small, transversely, oval area which appears as though it could be a glandular opening but which is probably the external evidence of an internal apodeme.

The eighth abdominal, or last, segment is equal in length to the two preceding segments. It becomes gradually narrowed to the caudal end where it terminates in three minute lobes. The two lateral lobes bear the last pair of spiracles (fig. 23, SP) which open between the lateral and median lobes. The lateral margins of the segment bear, near the base, two rounded protuberances on each side. These are densely covered with long yellowish setae. A row of shorter setae is located on the margin behind the protuberances. The dorsal surface of the segment is covered with conspicuous nodules, similar to those on the anterior segments. Some of these have a tendency to form longitudinal rows and others are so arranged as to form circular cleared areas. There are no dorsal protuberances near the base of the segment as described in the European *N. fasciculare* and in *N. californicum*.

The ventral aspect of the eighth segment is smoother than the dorsal aspect and has a row of small, setaceous tubercles near the lateral margins. The anal segment (fig. 2, ANS) is located near the base of the eighth segment. It is composed of two rounded lobes which surround the anal opening.

Spiracles. The drawing of the larva of *N. fasciculare* by Chapius and Candèze (1853, pl. 3, fig. 6) shows no trace of spiracles and in their description (p. 106) the authors state that in spite of minute study they had not been able to find the ordinary nine pairs of spiracles. They were able to find only a single pair of spiracles on the dorsal surface of the first abdominal segment located a little in front of the lateral prolongation of the tergum. The anterior spiracles of *N. fasciculare* are borne on a small conical projection, the writers further point out that "Les segments suivants n'offrent rien de semblable." (The following segments offer nothing of resemblance.)

Dufour (1862, p. 146) found seven pairs of spiracles in *N. fasciculare* on the lateral edges of the first seven abdominal segments, all of which were located at the summit of a pyramidal tubercle located in front of the lateral prolongations of the tergum ("lobule ciliè"). He pointed out that the first pair on the first abdominal segment is difficult to see, being hidden by the edge of the metathorax and not occupying the lateral edges of the segment as do the other pairs but on the dorsum of this segment. Dufour stated that, since he had not found spiracles on the thorax he refused to believe that one pair was not present. Laboulbène (1862) has an article on the subject in the same journal and same volume as that of Dufour. From specimens collected by Dufour, Perris and himself near Saint Sever he has studied the spiracles of this species in some detail. In this work the presence of a thoracic spiracle is reported. It is located laterally on the mesothorax in front of the coxa. This is the position of the mesothoracic spiracle on *N. californicum* (fig. 20, SP) as shown in Böving and Craighead's (1931, pl. 66) drawing. Laboulbène describes the second spiracle as being located dorsally on the first abdominal segment and the remaining ones, third to eighth, are noted as lying below the lateral extensions of the tergal lobes on abdominal segments 2–7, as described by Dufour. Laboulbène brought up the question as to the presence of a ninth pair of spiracles. On the dorsum of the eighth abdominal segment in *N. fasciculare* there is, near the base of the segment, a pair of tubercles which Laboulbène

thought might bear spiracles. Upon dissecting his only larva which had been preserved for many years, he could not find tracheal trunks associated with these tubercles and therefore doubted the presence of a ninth pair of spiracles. He furthermore was unable to find tracheae associated with the mesothoracic spiracle but thought this was due to the poorly preserved condition of the internal parts of his larva. The tubercles of the eighth abdominal segment (fig. 3, TUB) are found in *N. californicum*. They are only feebly evident in *N. unicolor*. Ganglbauer (*l. c.*) described spiracles at the tip of the eighth segment and Böving and Craighead (*l. c.* fig. C) illustrate the attenuated posterior end of the eighth abdominal segment of *N. californicum* which shows a well-defined pair of spiracles on the tips of this segment and they are faintly indicated although unlabeled in their drawing (*l. c.* fig. P) of *N. unicolor*. The present writers have dissected this segment (fig. 23) and readily found two tracheal trunks (TR) leading to these terminal spiracles (SP), whereas Louboulbène was unable to find any leading to the dorsal tubercles in *N. facsiculare* which he thought were probably spiracles. The spiracles of the eighth segment are located on the mesal side of the two, terminal, lateral lobes. The opening is a slit located on a somewhat oval peritreme (fig. 23, SP).

In *N. unicolor*, it is apparent that the mesothoracic spiracles are located dorsally on the cephalo-lateral angle of the segment, while those of *N. fasciculare* and *N. californicum* (fig. 20, SP) are located ventro-laterally. The abdominal segments of *N. unicolor* (fig. 1) on segments 1–7 likewise are dorsal and not closely associated with the tergal lobes as they are in the other two species. The eighth abdominal (9th pair in the series) spiracles are located on the terminal lateral lobes and are concealed by their location on the mesal side of the lobes.

Nosodendron californicum Horn

COMPARISON WITH N. UNICOLOR SAY

Four larvae, two mature and two half-grown, of *N. californicum* Horn available for study were collected at sap of a wound on white fir at Ashland, Oregon, May 10, 1915, by H. G. Champion. One other larva accompanied by two adults was available but without collection data. These are readily distinguished from *N. unicolor* by the fact that only the first abdominal spiracle is located dorsally and the others laterally, and the tergum of the last abdominal segment has two conspicuous dorsal tubercles. In these respects, this species resembles the European *N. fasciculare* more closely than it does our eastern species *N. unicolor*. Horn (1874, p. 22) in his original description of the adult of *N. californicum* pointed out that in the possession of "elytral tufts *N. californicum* resembles the transatlantic species *fasciculare*."

The largest available larvae measured about 10.3 mm. long with a head width of 1.8 mm. These are probably fifth instar forms. The half-grown larvae were 5 mm. long and have a head width of 1.15 mm. and are probably second instar larvae.

In the smaller larvae only the first abdominal spiracle is visible from above while in the full-grown larvae the spiracles of abdominal segments 2–7 are placed laterally and are on the ends of conspicuous tubules located laterally but which are long enough to be seen from the

dorsum where they protrude immediately cephalad of the lateral protuberances of the tergum.

KEY TO KNOWN FIFTH INSTAR LARVAE OF NOSODENDRON

1. Spiracles of mesothorax and spiracles of abdominal segments 1–7 located on tergum; tergum of eighth abdominal segment without two conspicuous dorsal protuberances near base of the segment. (Eastern United States,) .... **unicolor**

1–. Spiracles of mesothorax located on the pleuron in front of mesothoracic leg; spiracles of abdominal segment 1, located dorsally and those of segments 2 to 7 located below and in front of the lateral protuberances; tergum of eighth abdominal segment with two conspicuous darkened tubercles near base of segment........ 2

2. Dorsum of abdominal segments with cuticular processes not arranged in longitudinal rows only faintly producing some smooth cuticular circles; eighth abdominal segment without distinct longitudinal ridges. (Western United States)........ **californicum**

2–. Dorsum of abdominal segments with cuticular processes arranged in six longitudinal rows; eighth abdominal segment with four longitudinal ridges. (European)........ **fasciculare**

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NEW SPECIES OF SCYMNUS
(Coleoptera: Coccinellidae)[1]

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Two specimens of *Scymnus* have come to the author's attention in recent years that are strikingly distinct from any described North American species of the genus and are herewith described.

Scymnus lodi n. sp.

This species has the metacoxal line forming a complete arc which places it in Group *D* of Horn or the subgenus *Pullus* Mulsant. The body is very broadly oval and convex, with the thoracic and elytral margins forming a slight notch where they meet. The entire upper surface is rufo-testaceous except for a parabolic black spot on the middle of the base of the prothorax extending to within one-fourth of the apex. The under surface is testaceous except that the meso- and metepimera are fuscous and there is a fuscous tinge along the outer margin of the epipleurae. The head, thorax and elytra are all evenly and closely punctate, with the punctures smallest and shallowest on the head and largest and deepest on the elytra. The pubescence is very pale yellowish, short on the head and thorax, and much longer and more conspicuous on the elytra. The last ventral segment of the male is evenly arcuately emarginate at the middle. Length 2.6 mm., width 2.1 mm.

In the keys of Horn ('95) and Casey ('99) this species runs to *S. pallens* Lec. from which it is readily separated by the black spot on the prothorax, the color of the under surface, punctuation of the upper surface and much greater size.

Holotype: Male. Lodi Township, Athens County, Ohio, Sept. 27, 1945, collector, Wm. C. Stehr. It was found in a lowland pasture under a stone with a colony of ants, *Crematogaster lineolata* Say, but whether it is a true myrmecophile is not known.

Scymnus ohioensis n. sp.

This species has the metacoxal line joining the first ventral suture which places it in Group *A* of Horn or the subgenus *Diomus* Mulsant. The body is slightly elongate oval and moderately convex, with the thoracic and elytral margins forming a distinct notch where they meet. The head and thorax are yellow testaceous with a small fuscous spot on the latter just in front of the scutellum. The elytra are black with anterior oblique sinuate yellow fasciae extending from the humeral angles to the middle of the length and inner fourth of the elytra, and with posterior oblique fasciae extending from the margin at three-fifths to the inner fifth at four-fifths their length. There is also a narrow pale margin extending from the posterior fasciae to the apex

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of the elytra. The entire under surface is pale yellow testaceous as are also the legs and antennae. The prosternal carinae are complete, slightly converging anteriorly, and not strongly developed. The head and thorax are evenly and closely but not deeply punctate. The punctures of the elytra are stronger and are evenly and rather closely placed. The pubescence is pale yellowish, very short and fine on the head and thorax and slightly coarser and longer on the elytra. Length 1.7 mm., width 1.1 mm.

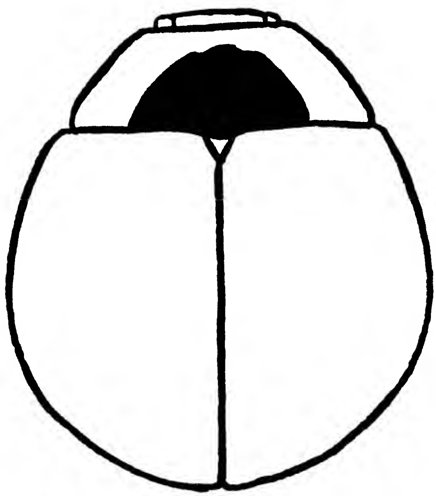

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FIG. 1. Dorsal view of *Scymnus lodi* n. sp.

2

FIG. 2. Dorsal view of *Scymnus ohioensis* n. sp.

In the keys of Horn ('95) and Casey ('99) this species would run to *S. liebecki* Horn. It differs, however, in the form of the elytral maculations, distinctly punctate head and larger size.

Holotype: Female. Green Township, Gallia County, Ohio, August 11, 1939, collector John H. Hughes, who kindly donated the type to the author. The specimen was swept from a growth of hemlocks but nothing further is known of its habits.

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2. **Horn, George H.** 1895. Studies in Coccinellidae. Trans. Am. Ent. Soc., 22: 81–114; 2 pl.

A NEW GENUS (COSTAMIA) AND SPECIES OF MEXICAN LEAFHOPPER

(Homoptera: Cicadellidae)

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Genus **Costamia** nov.

Apparently related to *Mesamia* but differing from it by a shorter vertex which is broad and slopes from pronotum to a thick margin. The vertex is twice as broad between eyes at base as median length. The face is convexly rounded. The elytra contain many supernumerary veins which are especially prevalent in the claval and costal areas. The first anteapical cell is divided into several small cells by cross veinlets which extend to the posterior border of the second anteapical cell thereby causing the first apical cell to be very small and triangular. There are two cross veins between the first and second sectors, giving a Deltocephaloid appearance.

Genotype *Costamia venosa* n. sp.

Costamia venosa n. sp.

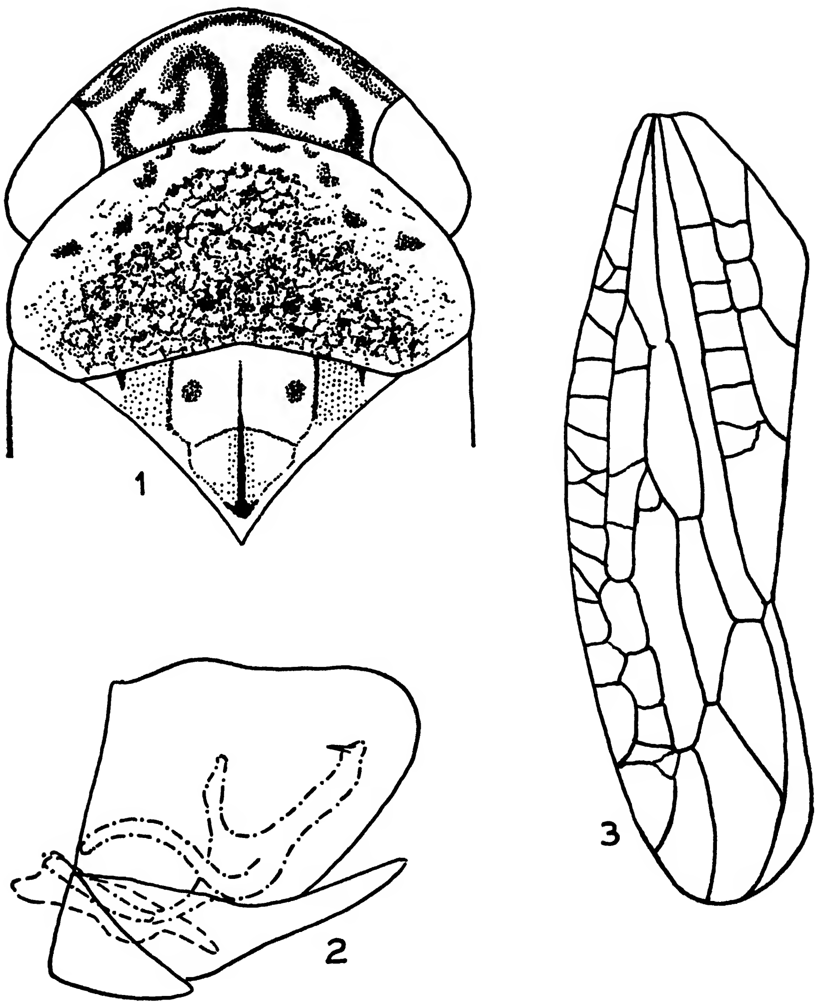
A pale brown species with darker brown markings. Length 4.5–5 mm.

Vertex short and broad, bluntly produced anteriorly, twice as wide between eyes as median length.

Color.—Yellowish to tawny, marked with dark brown. Face pale with a series of broad, dark brown arcs extending entirely across face. Vertex with a brown line on margin just below ocelli and a marginal brown line just above ocelli. Pattern on vertex somewhat variable due to the varying intensity of color. Usually a pair of longitudinal marks separated at middle which curve anteriorly toward the eyes and a curved mark next each eye, together forming four pale spots on the basal half. Pronotum pale along anterior margin, posterior two-thirds mottled with dark brown. Scutellum with basal angles, a pair of round spots on disc and a broad median longitudinal stripe on apical portion brown. Elytra milky white, subhyaline, veins and ramose pigment markings brown. Apical cells usually smoky.

Genitalia.—Male plates long, broad at base, concavely narrowed to produced, narrowly rounded apices. Aedeagus with a ventral dorsally directed finger-like process and a long slender process that arises ventromesally, curves dorsally and is directed anteriorly. The apical half is slender, slightly narrowed apically with a short spine on dorsal surface near apex.

Holotype male and a large series of paratype males collected at Iguala, Gurerrero, Mexico, September 11, 1939 (Plummer and DeLong) and October 25, 1941 (Good and DeLong). Types in author's collection



Costamia venosa n. sp. 1. Dorsal view of head and pronotum. 2. Lateral view of male genitalia. 3. View of left elytron.

CHINESE CHRYSOMELID BEETLES OF THE SUBFAMILY CHLAMISINAE[1]

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H. S. Barber shows me that *Chlamisus* Rafinesque 1815 must be used for the typical genus of this subfamily, instead of *Chlamys* Knoch 1801 (*nec* Röding in Bolten 1798) and other genonyms used in the past. Thus the name of the subfamily changes from Chlamydinae to Chlamisinae.

The subfamily is here considered in the old sense, excluding the Lamprosominae.[2]

Before 1940 only six species of this subfamily were known from China. In that year S. H. Chen[2] described five new species from China and newly recorded another, thus raising the total to twelve. In 1942 I[3] increased the number to twenty-nine, describing fifteen as new species. In this paper seven new species are described and one more is newly recorded from the area, bringing the number of Chinese species now known to thirty-seven for the subfamily.

For the purpose of this article the Formosan species are not included, though a few species from Formosa, the Loochoo (Ryu-kyu) Islands and Japan are included in the key on the basis of specimens I have studied. The records for these specimens are included at the end of this paper.

The material reported upon in this article comes largely from the California Academy of Sciences, with a few specimens from the United States National Museum and the American Museum of Natural History. The new species are in the California Academy of Sciences and were collected by me.

I am indebted to Mr. H. S. Barber of the United States Bureau of Entomology and Plant Quarantine for his counsel and aid in regard to nomenclature and other problems. I am also grateful to Prof. William E. Hoffmann, Associate Curator, Division of Insects, United States National Museum, for facilities put at my disposal in carrying on part of this study there; and to Dr. Roderick Craig and Mr. R. W. L. Potts of the University of California for help in preparing the illustration.

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[1]Formerly Chlamydinae.

[2]See Chen, S. H., On the Coleoptera Chlamydinae of China. Sinensia 11: 189–205 (1940).

[3]See Gressitt, J. L., Plant-beetles from South and West China. III. Clytrinae, Cryptocephalinae and Chlamydinae (Coleoptera). Lingnan Sci. Jour. 20: 325–376, Pls. 19–22 (1942). *Note:* Paratypes recorded in the aforementioned paper as being deposited in the United States National Museum and the California Academy of Sciences were partly mailed to the United States in the fall of 1941, but were returned after the Pacific War began, and are now in Canton.

KEY TO THE CHINESE[4] SPECIES OF CHLAMISUS

1. Pronotum or elytra at least partly marked with orange, red or pitchy brown, not uniformly black 2
Pronotum and elytra entirely black 21
2 (1). Pygidium lacking a clearly defined, slender, median ridge 3
Pygidium with a slender, more or less sharp-edged median ridge 5
3 (2). Raised areas of elytra mostly of fairly sharp ridges or tubercles 4
Raised areas of elytra entirely of very bluntly rounded tubercles; elytra largely reddish except for punctures and borders; anterior margin of pronotum and convex areas of head reddish orange; suture slightly raised .... **martialis**
4 (3). Body more than two-thirds as broad as long; pygidium triangular-hexagonal with indistinct ridges and poorly defined cavities; suture strongly raised; head and raised areas of pronotum rusty red; elytra largely reddish. (Japan) .... **japonicus**
Body less than two-thirds as broad as long; pygidium nearly round, with definite outer ridges and distinct cavities; suture not very strongly raised; head and anterior margin of pronotum partly black and partly pitchy red; elytra black with pitchy red raised areas... **rusticus**
5 (2). Front of pronotum marked with testaceous, orange or reddish in contrast to rest of dorsal surfaces which are black, or rarely black and pitchy red; pygidium lacking a transverse ridge just above middle connecting outer ridges 6
Front of pronotum without pale coloration in strong contrast to rest of dorsal surfaces, which latter are at least partly pitchy or reddish; pygidium generally with a more or less transverse ridge just above middle connecting outer longitudinal ridges 9
6 (5). Pronotum with anterior median portion orange or red; disc of pronotum without distinct linear ridges 7
Pronotum with anterior median portion yellowish testaceous; disc of pronotum with at least some fine linear ridges 8
7 (6). Elytral discs with several strong tubercles; more than anterior half of pronotum bright orange; length 5 mm. or more .... **semirufus**
Elytral discs almost lacking tubercles; a low one on each side of suture near middle, and a low vertical ridge on posterior declivity; pronotal markings dull reddish; length 3.6 mm .... **uniformis**
8 (6). Center of pronotal disc with ridges sharp and strongly raised; dorsal surfaces black except for front of pronotum; head marked with black around eyes and on center of occiput .... **superciliosus**
Center of pronotal disc with fine, fairly low ridges; dorsal surfaces extensively marked with dark red or pitchy; head testaceous; pronotum largely pale at sides .... **pallidiceps**
9 (5). Antennae reddish or ochraceous, at least basally 10
Antennae blackish; pronotum and elytra pitchy black with pale pitchy tuberosities; head pitchy to brownish; pronotum with subreticulate ridges above and large, irregular tubercles at sides .... **chinensis**
10 (9). Head without six longitudinal carinae on vertex 11
Head with six longitudinal carinae on vertex; body dirty brown, darker to black on depressed areas; pronotum with tubercles and ridges; elytra with tubercles not very prominent; lateral pygidial carinae sinuate .... **rugiceps**
11 (10). Central portion of pronotal disc with distinct, slender, linear ridges, sometimes partly sinuate 12
Central portion of pronotal disc with irregular tubercles, or in part with irregular short ridges, sometimes forming partial reticulations or zig-zag longitudinal ridges 15
12 (11). Elytra at least apparently truncate apically when viewed from above; pronotum with parallel ridges extending down posterior declivity 13
Elytra more or less rounded apically, with a tubercle above each posteriolateral angle; pronotum with submedian ridges not extending down posterior declivity 14

[4]Including certain species from Formosa, the Loochoo (Ryu-kyu) Islands and Japan.

13 (12). Pygidium broader than deep, transversely suboval, emarginate at upper corners, with lateral ridges recurved mediad posteriorly, their transverse connective situated near middle; raised areas of elytra orange red .... **angularis**

Pygidium as deep as broad, rounded-triangular, not emarginate at upper corners, with lateral ridges straight and directed obliquely laterad posteriorly, their transverse connective situated well dorsal to middle; raised areas of elytra pitchy red. (Japan, Formosa)........... **lewisi**

14 (12). Median groove of pronotum not bordered by parallel ridges anteriorly and bordered by rows of low tubercles at summit, a pair of parallel ridges above middle diverging at their lower ends and meeting a pair of oblique ridges originating near summit................. **rufulus**

Median groove of pronotum bordered by a pair of longitudinal ridges which are slightly discontinuous at middle and give off about four irregular carinae externally which form a few closed or open reticulations .... **subferrugineus**

15 (11). Pygidium lacking a transverse ridge just above middle connecting lateral carinae..16

Pygidium with a transverse ridge just above middle connecting lateral carinae..17

16 (15). Pronotum not deeply grooved and not strongly carinate on posterior declivity, distinctly grooved and carinate anteriorly; elytral tubercles sharply defined; length 2.4 mm.......................... **castaneus**

Pronotum deeply grooved and strongly carinate on posterior declivity, lacking distinct ridges on anterior portion and sides; tubercles on posterior halves of elytra rather small; length 3.3 mm............ **cheni**

17 (15). Pygidium lacking two distinct transverse ridges connecting outer longitudinal ridges; pronotum without three distinct velvety black spots..18

Pygidium with two distinct transverse ridges connecting outer longitudinal ridges; pronotum with three distinct velvety black areas on anterior portion; dorsum pitchy black with numerous dark reddish tubercles and short ridges or reticulations.......... **velutinomaculatus**

18 (17). Posteriolateral declivity of central raised portion of pronotum rather rough, with some irregular tubercles, including fairly prominent ones anteriorly and near top; postmedian elytral tubercles steep-sided and very closely approaching suture............................19

Posteriolateral declivity of central raised portion of pronotum somewhat evenly punctured, almost without tubercles, except sometimes some low indistinct ones along top; postmedian elytral tubercles obtuse or obsolescent and not extremely close to suture..................20

19 (18). Body nearly three-fourths as broad as long, unevenly narrowed posteriorly, very slightly narrower across middle of abdomen than across humeri; tubercles on anterior halves of elytra ridged along tops.. **ferrugineus**

Body less than two-thirds as broad as long, somewhat evenly narrowed posteriorly, much narrower across middle of abdomen than across humeri; tubercles on anterior halves of elytra blunt and punctured on tops. (Formosa).................................. **formosanus**

20 (18). Dorsal surfaces entirely brick-red, paler anteriorly, with tubercles very scarce and very low; length nearly 5 mm.............. **rufescens**

Dorsal surfaces pitchy black to reddish with numerous tubercles; fairly low on pronotum and moderately high on elytra; length 3 mm., **spilotus**

21 (1). Pronotum distinctly pubescent.....................................22

Pronotum not distinctly pubescent..................................23

22 (21). Elytra sparsely, and pronotum thickly, clothed with very fine yellow pubescence... **setosus**

Elytra not pubescent; head and anterior portion of pronotum densely clothed with pale golden, adpressed, scale-like hairs; pygidium with oblique connective ridges between outer longitudinal ridges.... **pilifrons**

23 (21). Central portion of pronotal disc somewhat regularly convex, evenly rounded in lateral outline, at least to top of posterior declivity, with fairly even surfaces or with a few fine regular longitudinal ridges.....24

Central portions of pronotal disc unevenly convex, with irregular ridges or tubercles, not evenly rounded in lateral outline............29

24 (23). Pronotum very even, without any distinct ridges....................25

Pronotum with some fine longitudinal or oblique ridges...............26

25 (24). Pronotum shiny, regularly punctured, lacking a distinct broad groove at top of posterior declivity; scutellum deeply emarginate posteriorly, with very narrow lateral prolongations; head and legs largely orange ochraceous...**maculiceps**

Pronotum dull, irregularly punctured, with a broad distinct groove at top of posterior declivity; scutellum feebly emarginate posteriorly, with moderately acute lateral projections; head largely pitchy black..**piceifrons**

26 (24). Pygidium lacking three distinct and complete, equal, longitudinal ridges; head and legs completely black...........................27

Pygidium with three more or less sharply defined, complete, equal, sublongitudinal ridges, alternating with sparsely punctured shiny strips...28

27 (26). Pronotum with four subregular carinae; pygidium with a feeble, incomplete, longitudinal ridge on each side of, and parallel to, median carina; antennae ochraceous...........................**pallidicornis**

Pronotum with six partly sinuate carinae; pygidium with a complete and distinct, but sinuous and dull, ridge on each side of median carina; antennae dark...................................**aterrimus**

28 (26). Head and legs largely reddish brown; sides of pronotum distinctly punctured; pygidial ridges completely parallel.................**sexcarinatus**

Head and legs entirely black; sides of pronotum reticulate-granulose; lateral pygidial ridges not quite parallel near upper ends...**reticulicollis**

29 (23). Fourth antennal segment very distinctly thicker than third............30

Fourth antennal segment not very distinctly thicker than third........31

30 (29). Pygidium armed with a sharp tooth on each side near superior angles; surface not equally divided by three longitudinal carinae; outer sections much broader than inner.......................**stercoralis**

Pygidium not armed with a prominent tubercle on each side near superior angles; surface divided into four equal parts by three longitudinal carinae.......................................**clermonti**

31 (29). Fifth antennal segment similar to third and fourth or very slightly flattened and broadened, but not subtriangular or hairy.............32

Fifth antennal segment at least subtriangular and hairy, generally similar to sixth and following.................................34

32 (31). Pygidium with lateral ridges sinuous, but not both joining median carina below middle and with a transverse connective above middle...33

Pygidium with lateral ridges connected by a transverse ridge above middle and turning suddenly behind middle and joining median carina perpendicularly, thus forming four subrounded cavities; occiput with a deep depression; elytra truncate apically......**diminutus**

33 (32). Body shiny black; head largely reddish testaceous; each side of prothorax with a single large tubercle; first abdominal segment with one tubercle at each side; length 3–3.9 mm................**montanus**

Body black with a bronzy sheen; head black; side of prothorax with two tubercles; first abdominal segment with two tubercles on each side; length 2.5–2.8 mm..............................**palliditarsis**

34 (31). Head entirely, or largely, pale reddish or orange....................35

Head entirely black or pitchy except for mouthparts..................37

35 (34). Head entirely reddish; length 3.3–3.5 mm..........................36

Head not entirely reddish; length 3.8–4.3 mm.; occiput without a very distinct depression; pygidium with lateral carinae extending ventrad to a raised, apical, punctate area, and with about 30 punctures in each lateral depression; fifth antennal segment not quite as broad as long...**latiusculus**

36 (35). Elytral suture distinctly toothed only in posterior two-thirds; occiput with a slight depression.................................**capitatus**

Elytral suture distinctly toothed throughout, except at extreme apex; occiput with a median groove...............................**ruficeps**

37 (34). Prosternum subparallel-sided in basal quarter, basal third or basal half 38
Prosternum triangular, and not subparallel-sided, basally 40

38 (37). Elytral discs each with seven or more prominent tubercles and other lesser ones; central portion of pronotum not almost perpendicular before and behind; tarsi black 39
Elytral discs without any very large tubercles; central portion of pronotum almost vertical before and behind; tarsi yellow .... **yunnanus**

39 (38). Pronotum not very uneven, with three pairs of oblique or sublongitudinal ridges on upper portion; dorsum shiny black .... **aterrimus**
Pronotum very uneven, with irregular, in part reticulating, ridges and tubercles; dorsum with a purplish to violet tinge .... **nigripes**

40 (37). Each side of pronotum with a large, prominent tubercle or with several small, but distinct, tubercles 41
Each side of pronotum with a single low tubercle, and disc with several areoles on each side; each elytron with about twelve principal tubercles; length 2.5–3 mm .... **fulvitarsis**

41 (40). Elytral apices not distinctly truncate and posteriolateral angles not prominent; prothorax broad anteriorly; each side of pronotum with a single large tubercle; median groove of pronotum not very deep or well defined 42
Elytral apices distinctly truncate and posteriolateral angles prominent; prothorax almost acute anteriorly; each side of pronotum with several tubercles; median groove of pronotum deep and well defined, **tuberculithorax**

42 (41). Prosternum with posterior half narrow and subparallel-sided; occiput strongly concave; premedian and postmedian transverse tubercles of each elytral disc connected by an even longitudinal ridge. (Loochoo Islands) .... **geniculatus**
Prosternum nearly forming an equilateral triangle, very slightly produced at apex; occiput plane; pre- and post-median transverse tubercle of each elytral disc not connected by an even longitudinal ridge, **prominens**

ENUMERATION OF THE CHINESE SPECIES OF CHLAMISUS

Chlamisus angularis (Gressitt), new combination

Chlamys angularis Gress., 1942, Lingnan Sci. Jour. 20: 355, 356, pl. 22, fig. 2 (N. Kwangtung).

Distribution: S. China (Kwangtung).

Chlamisus aterrimus (Gressitt), new combination

Chlamys aterrima Gress., 1942, Lingnan Sci. Jour. 20: 355, 357, pl. 21, fig. 6 (Hainan I.).

Additional specimens (Calif. Acad. Sci.) were collected at Ta-hian, near Five Finger Mts., Hainan, June 12, 1935, Gressitt; Ta-hau, west of Nodoa, Hainan, July 7, 1935, Gressitt; and Dwa-bi (Tai-pin), near Loi Mother Mt., Hainan, July 22, 1935, Gressitt.

Distribution: Hainan Island.

Chlamisus capitatus (Bowditch), new combination

Chlamys capitata Bowd., 1913, Trans. Amer. Ent. Soc. 39: 18 (Ha-lang); Chen, 1940, Sinensia 11: 193, 197.

Distribution: China ("Ha-lang").

Chlamisus castaneus (Chen), new combination

Chlamys castanea Chen, 1940, Sinensia 11: 193, 201 (S. China).

Distribution: S. China.

Chlamisus cheni (Gressitt), new combination

Chlamys cheni Gress., 1942, Lingnan Sci. Jour. 20: 355, 359 (Omei Shan).

Distribution: West China (Szechuan).

Chlamisus chinensis (Baly), new combination

Chlamys chinensis Baly, 1877, Jour. Linn. Soc. London 14: 345 (China); Chen, 1940, Sinensia 11: 193, 199.

Distribution: China (not further specified).

Chlamisus clermonti (Achard), new combination

Chlamys clermonti Ach., 1919, Ann. Soc. Ent. Belg. 59: 36 (Tchao-Pin-Io); Chen, 1940, Sinensia 11: 193, 197.

Distribution: China ("Tchao-Pin-Io").

Chlamisus diminutus (Gressitt), new combination

Chlamys diminuta Gress., 1942, Lingnan Sci. Jour. 20: 358, 359, pl. 21, fig. 2 (Hainan; Kwangtung; Hupeh).

Additional specimens (Calif. Acad. Sci.) were taken at Nanking, Kiangsu, Mar. 20, Apr. 30 and May 4, 1923, and Hangchow, Chekiang, May 18, 1923, by E. C. Van Dyke; and Ta-hian, near Five Finger Mts., Hainan, June 11, 1935, Gressitt, and Ta-hau, west of Nodoa, Hainan, July 4, 1935, Gressitt.

Distribution: S. China; E. China; Hainan Island.

Chlamisus ferrugineus Gressitt, new species

Plate I, figure 6

Robust, irregular at sides; truncate apically; rough and tuberculate. Largely reddish ochraceous, marked with black and pitchy: head with lower border of frons and central portion and upper exposed border of occiput blackish; antennae testaceous basally, slightly pitchy distally; prothorax with scattered punctures pitchy and depressed, closely punctured, areas black; scutellum and basal and sutural margins of elytra pitchy; elytral discs reddish ochraceous with punctures pitchy and deepest depressed areas and a stripe on each humerus blackish; ventral surfaces of body pitchy to blackish with central portion of prosternum, two stripes on each side of metathorax, swollen portion of first abdominal sternite, most of last sternite and raised areas of pygidium, reddish; legs ochraceous with a pitchy band across outer portion of each femur and tibia.

Head nearly circular in anterior view, somewhat densely and subcoarsely punctured, rather even except for a narrow raised area on each side of occiput; labrum about three times as broad as long; clypeus slightly emarginate anteriorly. Antennae about as long as width of head; scape twice as long as broad; second segment transverse; third and fourth subequal, subcylindrical and slightly longer than broad; fifth to tenth thick, broader than long; last subtriangular. Prothorax four-sevenths as long as broad, irregular at sides, broadly rounded anteriorly, strongly swollen and irregular above; lateral outline strongly convex, somewhat irregular, vertical anteriorly, concave just before summit, deeply concave at middle of posterior declivity; surface with dense to moderately sparse, small, deep punctures interrupted by numerous tubercles or short, irregular ridges; lower portion of each side

with several subregular ridges, mostly parallel to borders, the central one highest; central portion of disc with a pair of slightly raised areas near anterior border, a long, very sinuous, interrupted ridge across middle of front and reaching anterior border at sides, several partly connected tubercles on each side of upper portion, the highest at top of lateral declivity and moderately prominent ones on each side just before and just behind summit; posterior declivity with a longitudinal ridge on each side of lower portion. Scutellum broad, acute ecto-apically, moderately emarginate posteriorly; surface irregular, concave behind center. Elytra strongly constricted behind humeri; sides slightly irregular, narrowed posteriorly; apices truncate, with posteriolateral tubercles forming corners and projecting almost to apical margin; disc of each with a longitudinal tubercle near middle of base, two placed obliquely before middle, the inner one near suture, a transverse one by suture just behind middle, followed by about four smaller ones, one adjacent to suture, and two large ones: one at top of posterior declivity, near suture, the other just above posteriolateral angle. Ventral surfaces of body subcoarsely reticulate-punctate, the punctures shallow but with a small deep puncture in the center of each; each side of first abdominal sternite with about four raised areas. Prosternum with anterior half broadly scutiform, almost rectangular; remainder nearly one-half as broad, narrowly subscutiform, slightly widened behind middle. Pygidium as broad as deep, widest between middle and base, with a median ridge and a pair of broad, rough, lateral ridges which are sinuous, with a transverse connective above middle, then arched, recurved mediad and disappear before apical swellings; surface otherwise sparsely punctured. Legs irregularly punctured. Length 3.32 mm.; breadth 2.32 mm.

Holotype: (No. 5452, Calif. Acad. Sci., Entom.) Hong San, alt. 900 meters, S. E. Kiangsi Prov., S. E. China, June 25, 1936, J. L. Gressitt.

Differs from ***rufulus*** Chen in having the pronotum much less regular, with scattered tubercles instead of low, subregular ridges.

Distribution: S. E. China (S. Kiangsi).

Chlamisus fulvitarsis (Achard), new combination

Chlamys fulvitarsis Ach., 1919, Ann. Soc. Ent. Belg. 59: 38 (Tchoa-Pin-Io); Chen, 1940, Sinensia 11: 193, 195; Gressitt, 1942, Lingnan Sci. Jour. 20: 356, 361.

Distribution: "Tchao-Pin-Io"; Chekiang.

Chlamisus latiusculus (Chujo), new combination

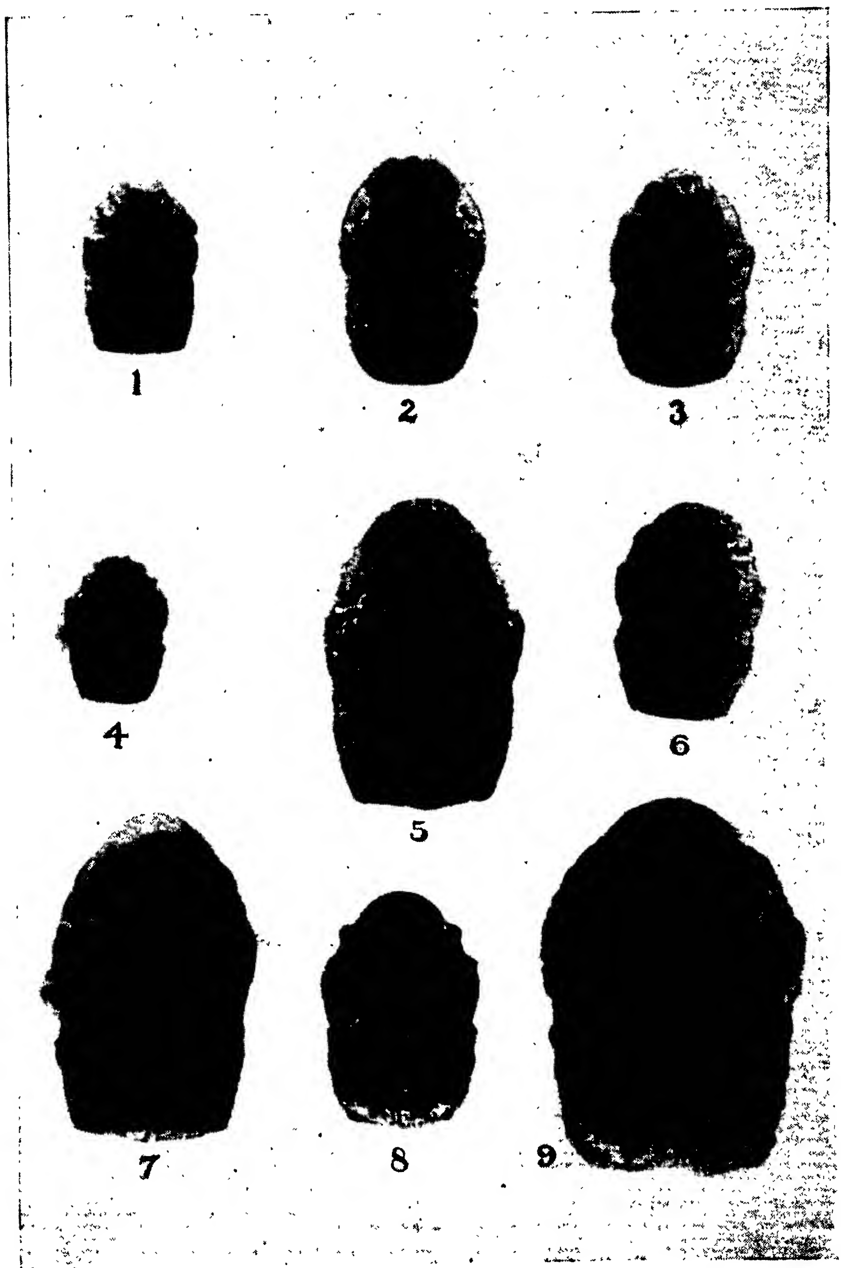
Exema latiuscula Chujo, 1940, Trans. Nat. Hist. Soc. Formosa 30: 284 (C. Formosa).
Chlamys latiuscula Gressitt, 1942, Lingnan Sci. Jour. 20: 355, 356, 361 (Hainan).

Distribution: Formosa; Hainan I.

EXPLANATION OF PLATE

(Magnified × 9.16)

Fig. 1. *Chlamisus superciliosus* Gressitt; holotype. 2. *Chlamisus uniformis* Gressitt; holotype. 3. *Chlamisus rufulus* (Chen); S. Kiangsi. 4. *Chlamisus pallidiceps* Gressitt; holotype. 5. *Chlamisus velutinomaculatus* Gressitt; holotype. 6. *Chlamisus ferrugineus* Gressitt; holotype. 7. *Chlamisus rufescens* Gressitt; holotype. 8. *Chlamisus prominens* Gressitt; holotype. 9. *Chlamisus stercoralis* (Gressitt); Fukien.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Chlamisus maculiceps (Gressitt), new combination

Chlamys maculiceps Gress., 1942, Lingnan Sci. Jour. 20: 355, 361, pl. 21, fig. 4 (N. Kwangtung).

An additional specimen (Calif. Acad. Sci.) was taken at Gang-keu, near Shang-hang, S. W. Fukien Prov., S. E. China, July 25, 1936, J. L. Gressitt.

Distribution: S. China (Kwangtung; Fukien).

Chlamisus martialis (Gressitt), new combination

Chlamys martialis Gress., 1942, Lingnan Sci. Jour. 20: 354, 362 (Kwangtung).

One specimen (Calif. Acad. Sci.) provisionally referred to this species was collected at Nanking, Kiangsu, E. China, Apr. 30, 1923, by E. C. Van Dyke.

Distribution: S. China (Kwangtung; Kiangsu).

Chlamisus montanus (Gressitt), new combination

Chlamys montana Gress., 1942, Lingnan Sci. Jour. 20: 356, 363 (Szechuan).

Distribution: W. China (Szechuan).

Chlamisus pallidiceps Gressitt, new species

(Plate I, figure 4)

Small, rugose-punctate. Testaceous to black; head pale testaceous, duller on depressed portion of occiput and on genae and mandibles; eyes black; antennae ochraceous, duller distally; pronotum testaceous on anterior two-fifths, except for anterior border which is brownish, black on remainder, with raised areas and part of each lateral groove ochraceous; scutellum black; elytra dark pitchy red-brown, black on humeri, borders, some of tubercles, and before apices; ventral surface black, slightly tinged with ferrugineous; legs testaceous, tinged with pitchy on outer edges of femora and tibiae.

Head slightly deeper than wide, slightly convex, reticulate-punctate, slightly depressed between antennal insertions and along median line of occiput. Antennae somewhat flattened; segments mostly broader than long; scape large, gradually thickened distally. Prothorax not quite as wide as elytra; pronotum subtrapezoidal, rounded anteriorly, strongly swollen dorsally; lateral outline evenly arcuate anteriorly, somewhat steeply declivitous from summit towards scutellum, with two slightly transverse swellings just above latter; surfaces deeply punctured, the punctures shallower and sparser anteriorly and on raised portions of sides; dorsum with two pairs of irregular longitudinal ridges, the inner pair extending from anterior margin to top of posterior declivity, the outer pair less complete, merging with the inner pair before summit. Scutellum short, shallowly emarginate posteriorly. Elytra slightly longer than broad, strongly narrowed just behind humeri; surfaces coarsely rugose-punctate; each with a large humeral swelling, a moderate swelling at middle of basal margin, and about eight discal tubercles of varying magnitude. Ventral surface of body coarsely and shallowly reticulate-punctate. Prosternum broadly triangular in basal half, moderately narrow at middle, somewhat diamond-shaped apically, with lateral and apical angles subacute. Pygidium broadly scutiform, with three subparallel longitudinal ridges, the outer

ones linear; remainder deeply, but not very closely, punctured. Legs closely punctured. Length 2.4 mm.; breadth 1.58 mm.

Holotype: Male (No. 5453, Calif. Acad. Sci., Entom.) Ta-han, alt. 750 meters, near Red Mist Mt., C. Hainan Island, S. China, June 22, 1935, J. L. Gressitt.

Differs from *semirufus* Chen in being only about one-half as large, in having the pale portion of the pronotum more testaceous, less extensive and less well defined, and in having the top of the pronotal disc with some fine, regular ridges.

Distribution: Hainan Island.

Chlamisus pallidicornis (Gressitt), new combination

Chlamys pallidicornis Gress., 1942, Lingnan Sci. Jour. 20: 355, 365, pl. 21, fig. 1 (N. Kwangtung).

Distribution: S. China (Kwangtung).

Chlamisus palliditarsis (Chen), new combination

Chlamys palliditarsis Chen, 1940, Sinensia 11: 193, 196 (Kwangsi; Szechuan).

Distribution: S. China (Szechuan; Kwangsi).

Chlamisus piceifrons (Gressitt), new combination

Chlamys piceifrons Gress., 1942, Lingnan Sci. Jour. 20: 355, 366, pl. 22, fig. 4 (Hainan I.).

Distribution: Hainan Island.

Chlamisus pilifrons (Léfevre), new combination

Chlamys pilifrons Lef., 1883, Ann. Soc. Ent. France (6)3: Bull. p. LXII (India); Chen, 1940, Sinensia 11: 192, 194 (Kweichow); Gressitt, 1942, Lingnan Sci. Jour. 20: 356, 367 (Yunnan).

Distribution: E. India; S. W. China (Yunnan; Kweichow).

Chlamisus prominens Gressitt, new species

Plate I, figure 8

Medium-sized; gibbous, polytuberculate and carinate. Largely blackish, in part tinged with ferrugineous; head reddish brown on frons, pitchy black on occiput; labrum red; antennae reddish ochraceous; pronotum and scutellum pitchy black; elytra dark pitchy red brown, black along extreme base and suture; ventral surfaces of body pitchy black, reddish on prosternum and slightly reddish on pygidium; legs brown with exposed portions partly pitchy; tarsi ochraceous.

Head very slightly deeper than wide, densely punctate, except for a small impunctate area on each side of center adjacent to antennal insertions; vertex slightly depressed between antennal insertions; occiput slightly depressed medially; labrum prominent, parallel-sided. Antennae serrate; scape three times as long as broad; postmedian segments flattened and produced ectoapically. Prothorax slightly over two-thirds as long as broad, strongly raised dorsally, raised portion with three pairs of radiating, sinuous, in part interrupted ridges, more or less converging posteriorly on each side of summit; posterior declivity steep, but becoming horizontal before scutellum; surface rather deeply punctured; each side with a single large tubercle. Scutellum broad, with projecting, subacute posteriolateral angles, feebly emarginate posteriorly. Elytra subrectangular, slightly widened and swollen at

humeri and somewhat rounded posteriolaterally; disc of each with four incomplete subsinuous longitudinal ridges, most strongly raised on basal portion of second ridge, with three transverse connectives near middle, and confusedly terminating in some subapical raised areas and tubercles; intervening areas coarsely punctured. Ventral surfaces of body deeply punctured with varying density. Prosternum almost forming a perfect equilateral triangle, acute apically. Pygidium broadest near dorsal margin, with a low tubercle at each border near broadest point, with three longitudinal ridges: middle one narrower and less strongly raised, and a suggestion of a transverse connection dorsal to middle; surface deeply and not very densely punctured. Legs finely punctured. Length 3.5 mm.; breadth 2.4 mm.

Holotype, male (No. 5454, Calif. Acad. Sci., Entom.), Hangchow, Chekiang Prov., E. China, May 23, 1923, E. C. Van Dyke.

Differs from *geniculatus* Jacoby in having the prosternum forming an equilateral triangle, the occiput plane and the pre- and post-median transverse tubercles of each elytral disc not connected by an even longitudinal ridge.

Distribution: E. China (Chekiang).

Chlamisus reticulicollis (Gressitt), new combination

Chlamys reticulicollis Gress., 1942, Lingnan Sci. Jour. 20: 355, 367, pl. 21, fig. 3 (N. Kwangtung).

One specimen (Calif. Acad. Sci.), tentatively referred to this species, was taken at Nanking, Kiangsu, E. China, Apr. 30, 1923, by E. C. Van Dyke.

Distribution: S. China (Kwangtung; Kiangsu).

Chlamisus rufescens Gressitt, new species

Plate I, figure 7

Large, subcylindrical. Entirely reddish brown of an ochraceous to pale ferrugineous shade, slightly paler on middle of frons, sides of occiput and anterior portion of pronotum, duller on sides of abdominal segments, and extreme basal, apical and sutural borders of elytra; eyes pale golden with dark centers; mandibles and tarsal claws pitchy black.

Head nearly as broad as long, feebly convex, coarsely and shallowly punctured, very slightly depressed in center between eyes. Antennae fairly slender, with scape, third and fourth segments much longer than broad and median segments fully as long as broad. Prothorax not quite as broad as elytra, slightly over two-thirds as long as broad; surfaces finely rugose-punctate almost throughout, with irregular raised reticulations anteriorly and tubercles or short irregular ridges posteriorly, both uniting medially to form a pair of subregular longitudinal ridges on dorsal raised portion of disc, slightly interrupted at beginning of posterior declivity, which is very gradually sloped and deeply emarginate at apex above scutellum. Scutellum broad, subcarinate medially, with posteriolateral angles strongly protruding and forming a moderately emarginate apex. Elytra moderately narrowed behind humeri, subtruncate apically; surface of each coarsely rugose-punctate and with a few very feebly raised tubercles except for two at top of posterior declivity of each, which make the latter subvertical and concave. Ventral surfaces of body with reticulate punctures of varying

sizes. Prosternum with basal portion short and broadly triangular, the remaining three-fifths slender, slightly broadened posteriorly and rounded apically. Pygidium broadest just above middle, deeply concave and sparsely and deeply punctured at each side, with a narrow median ridge and a pair of sinuous outer ridges which almost meet median ridge just above center. Legs stout, shallowly punctured, with short white hairs arising from punctures. Length 4.85 mm.; breadth 3.17 mm.

Holotype: Male (No. 5455, Calif. Acad. Sci., Entom.), Yim-na San (Yam-na Shan), alt. 800 meters, N. E. Kwangtung Prov., S. E. China, June 14, 1936, J. L. Gressitt.

Differs from *semirufus* Chen in not having any contrasting markings; in being brick-red, slightly paler anteriorly, and in having the pygidium with a transverse ridge connecting lateral carinae near middle.

Distribution: S. China (Kwangtung).

Chlamisus ruficeps (Chen), new combination

Chlamys ruficeps Chan, 1940, Sinensia 11: 193, 198 (Kwangsi).

Distribution: S. China (Kwangsi).

Chlamisus rufulus (Chen), new combination

Plate I, figure 3

Chlamys rufula Chan, 1940, Sinensia 11: 193, 200 (Kwangsi).

Four specimens (Calif. Acad. Sci.) were taken at Mei-hsien (Kaying), alt. 200 meters, N. E. Kwangtung Prov., June 18, and Tai-au-hong, alt. 350 meters, S. of Sungwu, S. E. Kiangsi Prov., July 7, 1936, S. E. China, J. L. Gressitt.

Distribution: S. China (Kwangsi Kwangtung, and S. Kiangsi).

Chlamisus rugiceps (Chen), new combination

Chlamys rugiceps Chen, 1940, Sinensia 11: 193, 198 (Kwangsi).

Distribution: S. China (Kwangsi).

Chlamisus rusticus (Gressitt), new combination

Chlamys rustica Gress., 1942, Lingnan Sci. Jour. 20: 354, 368 (Lan-t'au I., near Hong Kong; N. Kwangtung).

Distribution: S. China (Kwangtung; Hong Kong).

Chlamisus semirufus (Chen), new combination

Chlamys semirufa Chen, 1940, Sinensia 11: 193, 199 (Tonkin); Gressitt, 1942, Lingnan Sci. Jour. 20: 354, 370, pl. 22, fig. 3 (N. Kwangtung).

Several specimens (U. S. National Museum) were taken near Foochow, Fukien Prov., S. E. China, 1921 to 1924, by C. R. Kellogg. Three specimens (Calif. Acad. Sci.) were taken at Yim-na San, E. Kwangtung, June 10, Hong San, June 24 and Tai-au-hong, July 5, S. Kiangsi, 1936, J. L. Gressitt.

Distribution: Indo-China (Tonkin); S. China (Kwangtung; Kiangsi; Fukien).

Chlamisus setosus (Bowditch), new combination

Chlamys setosa Bowd., 1913, Trans. Amer. Ent. Soc. 39: 20 (Yunnan); Chen, 1940, Sinensia 11: 192, 193.

Distribution: S. W. China (Yunnan).

Chlamisus sexcarinatus (Gressitt), new combination

Chlamys sexcarinata Gress., 1942, Lingnan Sci. Jour. 20: 355, 370, pl. 21, fig. 5 (N. Kwangtung).

An additional specimen (Calif. Acad. Sci.) was taken at Wong-sa-shue, alt. 580 meters, S. E. Kiangsi Prov., S. E. China, July 9, 1936, by J. L. Gressitt.

Distribution: S. China (Kwangtung; S. Kiangsi).

Chlamisus spilotus (Baly), new combination

Chlamys spilota Baly, 1873, Trans. Ent. Soc. London 85 (Japan); Jacoby, 1885, Proc. Zool. Soc. London, 199.

Specimens (Calif. Acad. Sci.) were taken at Hakone, Honshu, Japan, April, 1895, J. Koebele; Kobe, Honshu, Japan, May 8, 1909, J. C. Thompson; Nanking, Kiangsu, E. China, May 3, 1923, E. C. Van Dyke; Tachikawa, near Tokyo, Japan, May 10, 1930, and Mt. Takao, west of Tachikawa, June 20, 1931, J. L. Gressitt. New to China.

Distribution: Japan; E. China.

Chlamisus stercoralis (Gressitt), new combination

Plate I, figure 9

Chlamys stercoralis Gress., 1942, Lingnan Sci. Jour. 20: 355, 371, pl. 22, fig. 5 (Hainan; Kwangtung).

One specimen (Amer. Mus. Nat. Hist.) was taken at Yen-ping, Fukien Prov., S. E. China, June 9, 1917, by the Rev. Harry Caldwell (Ac. 5148). Another (Calif. Acad. Sci.) was taken at Ta-hian (Ta-sian-kwan), near Five Finger Mts., S. C. Hainan Island, June 11, 1935, J. L. Gressitt.

Distribution: Hainan I.; Kwangtung; Fukien.

Chlamisus subferrugineus (Gressitt), new combination

Chlamys subferruginea Gress., 1942, Lingnan Sci. Jour. 20: 355, 373 (Hainan).

Distribution: Hainan Island.

Chlamisus superciliosus Gressitt, new species

Plate I, figure 1

Small, moderately narrow, subparallel-sided, narrowed anteriorly and truncate posteriorly. Shiny black with a very slight suggestion of brownish on elytra and ventral surfaces of body; head pale ochraceous with inner and upper borders of antennal insertions, eyes, frons and genae, and center of occiput, black; antennae pale ochraceous on first two segments, pitchy brown on remainder; central and lower portion of anterior declivity of pronotum yellow, paler than head; femora and tibiae very slightly reddish on inner portions; tarsi testaceous.

Head subcircular, feebly convex, shallowly depressed between antennal insertions and along postmedian portion of occiput, sub-coarsely and shallowly reticulate-punctate. Antennae with scape large: one-half as broad as long and longer than following three segments combined; second segment broader than long; third and fourth slender, subequal; fifth and following stout, broader than long, rather pubescent. Prothorax two-thirds as long as broad, nearly as wide basally as elytra, strongly narrowed anteriorly, somewhat sinuate at sides; disc strongly raised dorsally, in lateral view anterior declivity

steep, somewhat evenly arched to anterior margin; summit angularly concave and posterior declivity steep, convex, obtusely concave at bottom; surface somewhat deeply punctured, rather coarsely or sparsely so at sides and in front, densely so above; sides moderately convex; dorsum with three pairs of prominent carinae: first parallel, not quite reaching anterior border, second oblique, sinuate, meeting first pair at summit, third oblique, along top of lateral declivities, turning and continuing down posterior declivity. Scutellum partly covered by pronotum, apparently very short, with acute posteriolateral angles, slightly emarginate posterior border, and somewhat roughened surface. Elytra subrectangular, sinuate at sides, truncate posteriorly; each coarsely punctured, a single short auburn hair arising from each puncture and with about five distinct punctures and some lesser raised areas and incomplete ridges; most prominent tubercles situated at middle of basal margin, just before and just behind middle, and at top and side of posterior declivity. Ventral surfaces of body with large, spaced, shallow punctures on metasternum and smaller ones on abdomen. Prosternum constricted behind middle, spear-head shaped posteriorly. Pygidium broader than deep, widest near base, with three subparallel and somewhat closely approximate longitudinal ridges, the outer ones not well defined; surface sparsely punctured, concave at sides. Length 2.7 mm.; breadth 1.65 mm.

Paratypes: Pale area of front of pronotum often equilaterally triangular, less extensive than in the holotype. Length 2.4–2.85 mm.; breadth 1.5–1.88 mm.

Holotype: (No. 5456, Calif. Acad. Sci., Entom.), Yim-na San (Yam-na Shan), alt. 600 meters, N. E. Kwangtung Prov., S. E. China, June 13, 1936, J. L. Gressitt. Paratypes (Calif. Acad. Sci. and Lingnan Nat. Hist. Mus.): Tsing-leong San, alt. 850 meters, N. E. Kwangtung Prov., June 4, 1936, Gressitt; Ta-han (Ta-hon), alt. 750 meters, central Hainan Island, June 21 (two specimens) and June 23 (one specimen), 1935, Gressitt.

Differs from *Chlamisus hanoiensis* (Bowditch), new combination, in lacking any tubercles or branching ridges on the pronotal disc, and lacking a distinct bronzy tinge.

Distribution: S. China (Kwangtung); Hainan Island.

Chlamisus tuberculithorax (Gressitt), new combination

Chlamys tuberculithorax Gress., 1942, Lingnan Sci. Jour. **20**: **356**, **374**, pl. **22**, fig. **6** (Hainan).

Distribution: Hainan Island.

Chlamisus uniformis Gressitt, new species

Plate I, figure 2

Medium sized; rather evenly convex and almost without tubercles, though coarsely punctured. Black, partly marked with ferrugineous: head largely reddish brown, blackish along median line of occiput and upper borders between superior eye-lobes; antennae reddish; pronotum sooty black with anterior border and irregular patches of reddish on anterior half and sides; elytra black, very slightly tinged with pitchy; ventral surfaces black or pitchy black; legs pitchy to reddish with tarsi ochraceous.

Head nearly round, feebly convex, subcoarsely punctured, slightly depressed between antennal insertions and along middle of occiput. Antennae with scape more than twice as broad as long, second segment short and stout, third and fourth slender, subequal, but not very long, and remainder moderately thickened and expanded externally. Prothorax two-thirds as long as broad, broadly rounded anteriorly, feebly sinuate at sides; lateral outline subevenly convex from anterior margin to summit, slightly tuberculate just behind summit and moderately declivitous posteriorly to posterior extremity; surfaces almost entirely covered with moderately coarse and moderately deep punctures, slightly smaller and denser at middle of sides and along median line, which consequently appears as a slightly depressed strip; reddish areas slightly raised, being more coarsely punctured or slightly tuberculate; a single tubercle on each side of top of posterior declivity, which is hardly grooved except between these two tubercles. Scutellum about twice as broad as long, bluntly acute ectoapically, moderately emarginate posteriorly, depressed behind center. Elytra very slightly longer than broad, sinuate laterally, constricted behind humeri, broadly rounded posteriolaterally, rounded truncate apically; each very coarsely punctured except on humerus which is finely corrugated, lacking prominent tubercles, with only the suggestion of the mid-basal, pre- and postmedian and apical ones, and with longitudinal ridges almost obsolete. Ventral surfaces of body coarsely reticulate-punctate on metathorax, more finely so on abdomen; sides of first abdominal segment without prominent swellings. Prosternum triangular anteriorly, slender posteriorly, somewhat wedge-shaped. Pygidium subtriangular, widest near base, raised along central portion, convex apically, with three subsimilar longitudinal ridges, each somewhat irregular, the outer ones subsinuate; depressed areas somewhat finely, deeply and sparsely punctured, more coarsely and densely so at apex. Legs rather coarsely and subreticulately punctured on exposed portion. Length 3.64 mm.; breadth 2.26 mm.

Holotype: (No. 5457, Calif. Acad. Sci., Entom.), Tsin-leong San (Tsing-leung Shan), alt. 850 meters, N. E. Kwangtung Prov., S. E. China, June 3, 1936, J. L. Gressitt.

Differs from *semirufus* Chen in having the elytral discs almost without tubercles instead of with several strong tubercles, and the pronotal markings dull reddish instead of bright orange, and in being smaller.

Distribution: S. E. China (Kwangtung).

Chlamisus velutinomaculatus Gressitt, new species

Plate I, figure 5

Moderately elongate, subcylindrical, broadest at humeri; rough, irregularly tuberculate; some velvety spots on pronotum. Dark pitchy red-brown, nearly black in places, including humeri and thoracic and abdominal sternites; tarsi and raised areas of head and pygidium paler reddish; pronotum with five velvety black spots on anterior part of raised central portion: two near anterior margin and three in a transverse row more dorsally, as well as some other somewhat similar black spots.

Head slightly deeper than wide, rather rough, somewhat convex in center between antennal insertions and irregularly raised on each side of occiput, which latter is grooved medially; surface irregularly, but for most part coarsely, punctured. Antennae slender; scape more than three times as long as broad, slightly arched; second segment fully as long as broad; third and fourth slender, subequal, each hardly longer than second; fifth somewhat broadened distally; remainder flattened, as broad as long, or broader than long. Prothorax nearly three-fourths as long as broad, irregular at sides, broadly rounded anteriorly, not very strongly swollen dorsally, somewhat uneven in lateral outline, but in the main somewhat regularly, and not very strongly, convex; posterior declivity feeble, concave in lateral outline; surface very irregularly punctured, both as to size and density of punctures, and with numerous low tubercles or subreticulate ridges; velvety spots depressed, very deeply punctured and with short erect black hairs, which are hard to distinguish; a tubercle on each side of top of posterior declivity. Scutellum transverse, produced ectoapically, emarginate-truncate posteriorly, carinate medially. Elytra subtrapeziform: moderately, and subevenly, narrowed posteriorly, subtransversely truncate apically; each very rough, with irregular large punctures and numerous tubercles of various sizes, the most prominent ones located as follows: one just before and one just behind middle, and one at top and one at side of posterior declivity; also with several deeply impressed areas: one at side just behind center, one before and one behind postmedian tubercle, one at side just before apex and one on posterior declivity; suture bearing slender acute teeth on posterior three-fourths, the teeth becoming obsolescent anteriorly. Ventral surfaces of body coarsely and shallowly reticulate-punctate; sides of first abdominal segment with three low swellings. Prosternum with anterior portion broadly triangular, twice as broad as long, and posterior portion narrow, subparallel-sided and subacute apically. Pygidium slightly deeper than wide, broadest between base and middle, broadly rounded and slightly arched apically, with three ridges: median one straight and narrow, outer ones irregular, sinuous, with transverse connectives above and below middle, thus forming eight depressed areas, which are concave, somewhat smooth-surfaced and with sparse, deep punctures. Legs shallowly and irregularly punctured. Length 4.62 mm.; breadth 3.15 mm.

Paratypes: General coloration brighter reddish brown to reddish ochraceous, with deeper portions of punctures and depressed areas, and velvety spots, black. Length 4.2–4.4 mm.; breadth 2.75–2.85 mm.

Holotype: (No. 5458, Calif. Acad. Sci., Entom.), Wong-sa-shue, alt. 550 meters, S. E. Kiangsi Prov., S. E. China, July 9, 1936, J. L. Gressitt. Paratypes: one (Lingnan Nat. Hist. Mus.), Gang-keu, near Shang-hang, S. W. Fukien Prov., S. E. China, July 28, 1936, J. L. Gressitt, and one (Calif. Acad. Sci.), Nodoa (Noh-tai), alt. 150 meters, Hainan Island, S. China, July 1, 1935, Gressitt.

The Hainan specimen is the palest.

Differs from *lewisi* Baly in having the pronotum with irregular tubercles instead of subregular ridges, and with the posterior portion depressed and subtuberculate instead of strongly compressed laterally

and ridged. The tubercles and ridges of the elytra are less sharp than in *lewisi*.

Distribution: S. China (S. Kiangsi; Fukien); Hainan Island.

Chlamisus yunnanus (Bowditch), new combination

Chlamys yunnana Bowd., 1913, Trans. Amer. Ent. Soc. 39: 308 (Yunnan); Chen, 1940, Sinensia 11: 193, 195.

Distribution: S. W. China (Yunnan).

APPENDIX

RECORDS OF EXTRA-CHINESE SPECIES

Chlamisus formosanus (Bates), new combination

A specimen (Calif. Acad. Sci.) was taken at Musha, central Formosa, May 19, 1932, J. L. Gressitt.

Chlamisus geniculatus (Jacoby), new combination

One specimen (Calif. Acad. Sci.) was collected near Naze (Nase), Amami-Oshima Island, northern Ryu Kyu Islands, June 9, 1932, J. L. Gressitt.

Chlamisus japonicus (Jacoby), new combination

Several specimens (Calif. Acad. Sci.) were collected at Nikko, Honshu, Japan, by Joseph Koebele.

Chlamisus lewisi (Baly), new combination

One specimen (Calif. Acad. Sci.) was taken at Unzen Hot Springs, Kyushu, July 8–12, 1923, E. C. Van Dyke.

Chlamisus nigripes (Chujo), new combination

One specimen (Calif. Acad. Sci.) was taken at Sakahen, near Karenko, east coast of Formosa, July 12, 1934, J. L. Gressitt.

A REVIEW OF THE LITERATURE ON SOIL INSECTICIDES, by H. C. GOUGH. 161 pages. The Imperial Institute of Entomology, 41 Queen's Gate, London, S. W. 7, 1945. Price, ten shillings.

Dr. Gough states in his introduction that the Review is limited strictly to soil insecticides, omitting the problem of soil sterilization, which is particularly concerned with micro-organisms, and the control of nematodes, myriapods and arachnids in the soil. The control of soil insects by poison baits is also excluded. He states further that the *Review of Applied Entomology* has been perused *in toto* as a basis for his work, although other works have been consulted. His bibliography of sixteen pages, including several hundred titles, is evidence of his thorough survey of published information.

Following a short discussion of methods of application, distribution of insecticides in the soil, methods of assaying toxicity, and effects on plants and micro-organisms, the body of the work treats the more important soil insecticides one by one, and under each lists the insect pests by orders against which the poison has been tried.

The Review is compactly written and its pages are somewhat larger than those of the Annals, hence an enormous amount of information is included in it. It should be an indispensable reference work in this field.—A. W. L.

OBSERVATIONS ON THE HABITS AND LIFE HISTORY OF A CHIGGER MITE, EUTROMBICULA BATATAS
(Acarina: Trombiculinae)

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INTRODUCTION

Although chiggers are severe pests in many parts of the world and are important disease vectors in a large area of the Far East, detailed life history studies have so far been published only for the Japanese species. Life history studies of this group have a peculiar importance from the standpoint of disease transmission, since an individual chigger feeds on a vertebrate host only once during its entire life, and in only one stage, the larva. The disease organisms must, therefore, pass from the larva of one generation through all the successive stages, including the egg, to the larva of the next generation. In the present paper the life history of one of the species of chiggers most commonly encountered in Panama is discussed.

From the Western Hemisphere about ninety species of Trombiculinae have been described. Most of these are known only from the larval stage, only about eight from the adult stage, and apparently but two, *Eutrombicula alfreddugèsi* (Oudemans) in North America and *E. göldii* (Oudemans) in South America are known in both larval and adult stages. The observations here described were made in Panama on *Eutrombicula batatas* (Linnaeus), which is the much discussed but little known pattata mite of Surinam. Larvae and adults of a few other species were correlated in Panama by Capt. Roy Melvin, and it is hoped that information on these will be published at a later date.

The classification of the trombiculine mites leaves much to be desired. There are twenty-five named genera in the world, all based on larval characters. About thirteen of these genera are known from the Western Hemisphere. The study of adults has gone quite independently, most of them having been placed in the genus ***Trombicula.***

NOMENCLATURE

The following appears to be the correct synonymy for ***Eutrombicula*** *batatas* (Linnaeus):

Acarus batatas Linnaeus, 1758, Syst. Nat., 10th Ed., Genus 235, Species 22.
Thrombidium batatas, Oudemans, 1905, Nova Guinea, 1903, vol. 5, p. 148.
Gen. ? *batatas*, Oudemans, 1912, Zool. Jahrb., Suppl. 14, Heft 1, p. 3.
Trombicula batatas, Ewing, 1931, Proc. U. S. Nat. Mus., vol. 80, Art. 8, p. 6; Schierbeek, 1937, Ann. Parasit. Hum. Comp., vol. 15, p. 329; Schierbeek, 1938, Acta Leidensia, vol. 12–13, p. 269; van Thiel and van Ommeren, 1940, Geneesk. Tidschr. Ned.-Ind., vol. 80, 0. 1638; Radford, 1942, Parasitology, vol. 34, p. 57.
? *Pattata-luis* van Stockum, 1904, Tijdschr. Kon. Nederlandsch Aardr.-kundig Gen. 1904, Verslag. Saramacca-Exp., p. 22.
Trombicula flui, van Thiel, 1930, Parasitology, vol. 22, p. 347; Ewing, 1931, Proc. U. S. Nat. Mus., vol. 80, Art. 8, p. 7.

Eutronbicula flui, Ewing, 1938, Jour. Wash. Acad. Sci., vol. 28, p. 294; Radford, 1942, Parasitology, vol. 34, p. 66.
Acariscus flui, Ewing, 1943, Proc. Ent. Soc. Wash., vol. 43, p. 64; Islas, 1943, An. Inst. Biol., Univ. Nac. Mexico, vol. 14, p. 441.
Trombicula hominis, Ewing, 1943, Proc. U. S. Nat. Mus., vol. 82, Art. 29, p. 5; Ewing, 1938, Jour. Wash. Acad. Sci., vol. 28, p. 294; Radford, 1942, Parasitology, vol. 34, p. 66.
Acariscus hominis, Ewing, 1943, Proc. Ent. Soc. Wash., vol. 45, p. 63.
Trombicula pastorae Boshell and Kerr, 1942, Rev. Acad. Colombiana Cien. Exact., Fisíco-Quím. y Nat., vol. 5, p. 12.

E. flui and *E. hominis* have not previously been considered as synonymous. It is evident, however, from a study of specimens and descriptions, that the supposed differences are largely the result of inaccurate observations and descriptions.

The third pedipalpal seta is described as simple for *hominis* (Ewing, 1933, 1943). Van Thiel (1930) failed to see it in *flui*, showing only the fourth but Ewing (1943) describes the third as branched. From Ewing's figure (1933) it seems certain that he, like van Thiel, failed to see the third seta and described instead the fourth, which is simple and is much more conspicuous than the third. In all Panamanian specimens which I have studied including those from the type locality of *hominis* the third seta of the pedipalp is branched, but its position is such that it is often difficult to see. Finally, certain of my Panamanian specimens were sent for comparison with the types of *hominis* to Ewing, his attention being drawn to the branching of the third pedipalpal seta. He identified them as undoubtedly *hominis*.

From a study of Ewing's (1943) descriptions it would appear that the prongs of the claws of the pedipalps are subequal in *hominis* while the outer is the longer in *flui*. However, the original description of *hominis* (Ewing, 1933) states that the outer is longer.

The dorsal abdominal setae are said to be thirty-two in number in *hominis*, thirty-four in *flui*. In unengorged specimens, the number of apparently dorsal setae ranges from thirty-two to thirty-six, depending on slight variations in the positions of the terminal abdominal setae and perhaps on the manner in which the specimen is flattened on the slide. In figure 1 there are indicated thirty-two dorsal abdominal setae not counting the near marginal "b" and "c." This is as in the *hominis* types as indicated in a letter from Dr. Ewing. In many specimens, however, "b" becomes clearly dorsal and "a" marginal or even, occasionally, dorsal, as shown on one side of van Thiel's figure of *flui*. There is no actual difference in the number of setae involved, but merely slight differences in position such as are often observed elsewhere on the body. On other parts of the body, however, such variations do not result in shifting setae from dorsal to ventral in position, and hence have never been considered important. It has not been possible to correlate these variations with other characters, such as the relative

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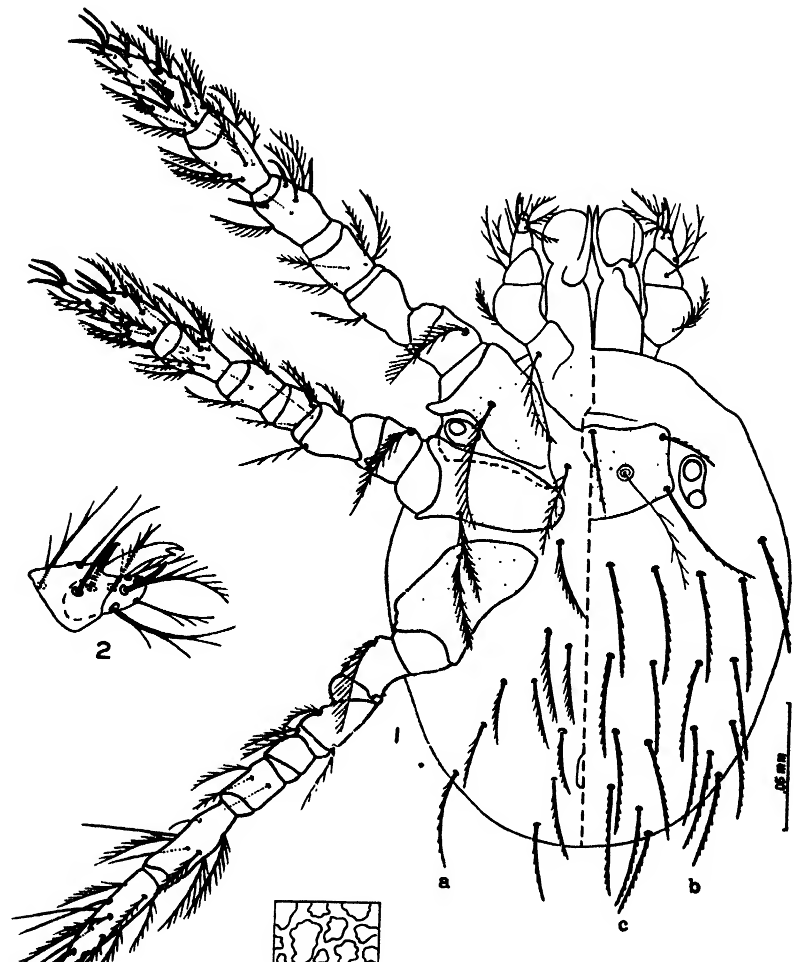
EXPLANATION OF PLATE I

Fig. 1, Larva of *Eutrombicula batatas*, dorsal view on right, ventral view on left. Fig. 2, Apex of pedipalp of larva. Fig. 3, Detail of sculpture of chorion of egg. Fig. 4, Section of same.


1
a
b
c
2
3
4
.01mm
.05 mm

sizes of the eyes. (See remarks on the larva for other notes on other variations in chaetotaxy.)

The anterior margin of the dorsal plate is correctly described and figured for *hominis* as biconcave. For *flui* it is described and figured as convex. From a study of van Thiel's (1930) figure of *flui* it is evident that he saw, not the anterior margin of the plate, but an arcuate fold that often develops in the integument in front of the plate. This fold extends between the anterolateral angles of the plate, and is commonly more conspicuous in unstained specimens on slides than is the margin of the plate. The anterior limit of the pitted area shown by van Thiel is actually near the anterior edge of the plate. As shown in figure 1 the pitted area extends almost to the margin of the plate. The excess length thus given the dorsal plate by van Thiel is responsible for the statement that the pseudostigmatic organs are about as long as the plate in *flui*, longer in *hominis*.

In passing it is well to state that in order to avoid similar errors it is desirable to study properly stained mites. A simple method of staining larvae, which because of their small size are troublesome to transfer from one liquid to another in preparation for mounting, is to dissolve a stain in the mounting medium. Both acid fuchsin and iodine crystals dissolve slowly in Berlese medium, giving it a strong color which is taken up by the mite integument.

From the evidence given by Schierbeek (1937, 1938) and van Thiel and van Ommeren (1940) there is very little doubt that *flui* is a synonym of *batatas*. Both were described from Surinam. Although the Linnaean description does not give diagnostic structural characters, the species was stated to attack man in a field. These authors found *flui* to be the only species commonly attacking man in Surinam, and therefore regarded *flui* as a synonym of *batatas*. The fact that both were described from open fields is a further indication that the synonymy is correct. At the earliest opportunity a specimen from Surinam should be designated as a neotype of *Acarus batatas* Linnaeus, in order to leave no further room for argument.

The generic name *Eutrombicula* is here used, *Acariscus* being considered a synonym. When *Acariscus* was named (Ewing, 1943) it was defined to include species previously placed in *Eutrombicula* but having more abdominal setae. Many species of *Eutrombicula* have twenty-two dorsal abdominal setae. The species placed in *Acariscus* have 26, 28, 30, 32, 34, 38, and 50 in the various species. In itself this arrangement is not tenable, there being much greater differences among the species of *Acariscus* than between *Acariscus* and *Eutrombicula*. The discovery in Panama of a species (as yet undescribed) with twenty-four dorsal

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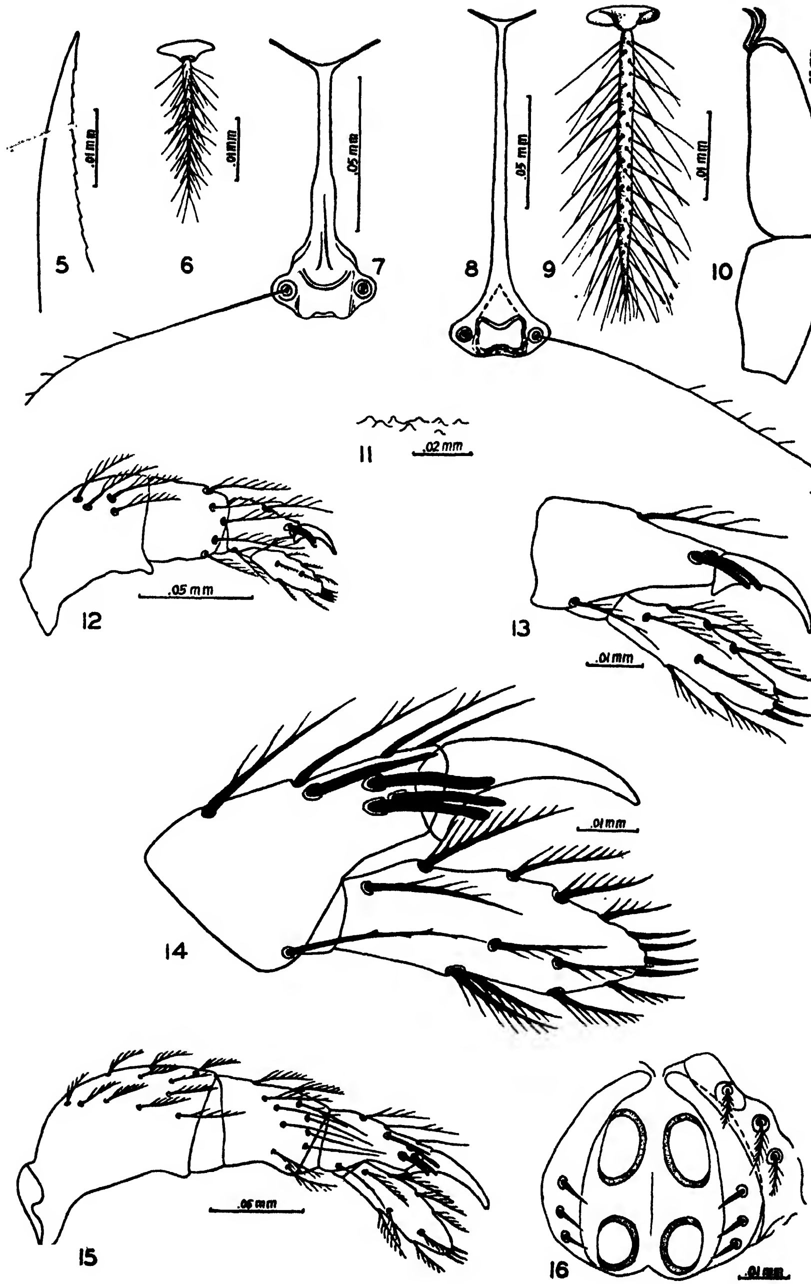
EXPLANATION OF PLATE II

Fig. 5, Apex of chelicera of nymph of *Eutrombicula batatas*. Fig. 6, Hair from posterior part of body of nymph. Fig. 7, Crista of nymph. Fig. 8, Crista of adult. Fig. 9, Hair from posterior part of body of adult. Fig. 10, Last two segments of anterior leg of adult. Fig. 11, Detail of integument of protonymph. Fig. 12, Inner view of pedipalp of nymph. Fig. 13, Inner view of apex of same. Fig. 14, Inner view of apex of pedipalp of adult. Fig. 15, Inner view of pedipalp of adult. Fig. 16, Genital area of nymph.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6
7
8
9
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11
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16
.01 mm
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abdominal setae completely bridges the gap between *Eutrombicula* and *Acariscus*. The ventral abdominal setae are similarly useless in separating these genera.

OCCURRENCE

As now known, *Eutrombicula batatas* ranges from Dutch Guiana to Colombia and Panama and north to Puerto Rico, Florida, Alabama and the state of Puebla, Mexico. New Panamanian locality records are as follows:

Canal Zone: Juan Mina, Summit. *Panama Province:* Panama City, San Francisco de la Caleta, Matías Hernández, Camarón, Chilibre, Las Guacas. *Colon Province:* Santa Rosa, Gatuncillo.

This is a species found in open sunlit places. It has not been collected in wooded or jungle areas. The nymphs and adults live, at least during the rainy season, on the surface of the soil or within one-half inch of the surface in areas of dense but short grass or other herbaceous vegetation. Frequent rains and the shade provided by the grass keep the soil surface moist. Adults of most other local species must be searched for in the leaf mold and debris of the forest or stream banks, or under rocks and logs, but to find the adults of *batatas* it is only necessary to part the grass where larvae are abundant and search for them on the soil surface. Indeed in morning and evening, when the sun does not strike the ground, adults and nymphs of *batatas* may be found walking about on open ground near the grass. At night, however, they become quiescent, often gathering in groups of as many as five or six in favorable small hollows in the soil.

The larvae occur on the grass and weeds sometimes in great numbers. They have not been found on logs, stumps, and the like where larvae of certain other species often occur. This agrees with the observations on this species made by van Thiel and van Ommeren (1940) in Dutch Guiana and indeed with the Linnaean account of the species. Larvae survive heavy rains, clinging to the grass blades or leaves of weeds. When the grass is wet with rain or dew the larvae are relatively inactive, although they are able to walk on the surface film of water. They are easily dislodged from wet grass, however, and will then cling to man or animals walking through the area. Greatest larval activity occurs after the grass becomes partially dry in the morning, usually between 8:30 and 9:30 a. m. on a clear day and continues until the temperature in the vicinity of the tops of the grass blades reaches about 40° C. At temperatures above this the larvae are not in evidence in any numbers, probably disappearing into the shade near the bases of the plants. When the sun is obscured by clouds the larvae are more or less active, but never in the numbers that are seen in bright sunlight in the morning immediately after the dew has dried.

This species apparently becomes abundant only in the grassy areas around houses and in villages where domestic animals, particularly chickens, are numerous. At Santa Rosa, Panama, where most of my observations were made, larvae have been collected attached to man, goat, dog, rat, chicken, ruddy ground dove (*Chaemepelia rufipennis*), ani (*Crotophaga ani*), and striped cuckoo (*Tapera naevia*). Other recorded hosts are horse, guinea hen, southern meadowlark (*Sturnella magna*

argutula), brown thrasher (*Taxostoma rufum*) (Ewing, 1943), turkey (Boshell and Kerr, 1942), and lizards (Schierbeek, 1937). The species is evidently rare on reptiles, however.

On children wearing only loose clothing over 80 per cent of the larvae attached in the groin and under the armpits. In one instance 138 attached larvae were found on a twelve-year-old boy who, after being freed of all chiggers, played in chigger infested grass for three hours. On adults many larvae attach on the ankles under socks, in the groin, and about the belt line. But few reach as high as the armpits. On chickens, the most important hosts where I have studied *E. batatas*, the chiggers tend to gather in groups about the vent, under the wings, and elsewhere on the body. They are most numerous on young, partially feathered birds. As many as a thousand have been taken from a single young chicken. Older chickens become equally favored hosts if some of the body feathers are clipped off. On goats the larvae gather in masses under the bases of the legs.

Eutrombicula batatas is abundant in favorable localities throughout the rainy season and larvae, at least, can be found during the first month of the dry season. After becoming gradually scarcer for several weeks, the larvae finally disappeared completely near Panama City about February 5, 1945. They reappeared there, after considerable rain, about May 30. At Santa Rosa, where there is considerably more rain, they disappeared about February 15, reappeared about May 10. How the species survives the dry season, when the grass becomes dry and brown, is not known. It has been observed that the soil cracks deeply in drying and it may be that the species passes the dry season from February to April or May deep in the soil where it is relatively moist. Attempts to find these mites by digging, however, have been unsuccessful.

LIFE HISTORY AND DESCRIPTIONS OF THE STAGES

Egg: The eggs are laid singly on the surface of moist soil. Melvin records laying of eggs in masses. This is certainly not the usual thing, but may have resulted from his method of forcing egg production by heat. Thus far, among numerous mounted females, not more than one egg has been found in an individual. Apparently the chorion is formed on only one egg at a time, which is laid before another chorion is formed.

The eggs are spherical, pale dull orange, about 0.15 mm. in diameter, the shell rather thick and with numerous, irregularly shaped depressed areas giving it a reticulate appearance.

Because of their dull coloration and minute size, the eggs must be searched for with a binocular microscope. Failure to find the eggs of *Eutrombicula alfreddugèsi* except in the bodies of females (Ewing, 1944) does not seem to be a good indication of ovoviviparity.

Deutovum: About four or five days after being laid, the egg shell breaks into anterior and posterior portions, which become separated from one another as shown in figures 18 and 19, exposing the median portion of a stage called by Miyajima and Okumura (1917) the deutovum. Ewing (1944) calls this the "cast cuticular exuvia of the fully developed embryonic larva." It should be pointed out that

Ewing's opinion was based on the figure given by Miyajima and Okumura which apparently shows the "deutovum" at a time when the larva is already moving about inside attempting to emerge, and does not give a good impression of the organism at this stage. Without expressing an opinion as to the true nature of the structure involved, the word deutovum will be used for convenience here.

The two portions of the egg shell may be easily removed from the deutovum exposing it as shown in figures 20 and 21. It is about 0.2 mm. long, obviously larger than the egg, perhaps having absorbed water. The surface is smooth, without setae or papillae, and the leg and pedipalpal sheaths show no segmentation except that indicated by the developing larval appendages within. It may be noted here that the leg sheaths are much more distinct, and separable from one another in some of the related mites such as *Manriquia*, in which the deutoval stage lasts several weeks. On the dorsum of the deutovum is a single spine.

The posterior part of the body is quite red, and the red ocular areas of the larva show through the deutoval integument. The trochanters of the larval legs extend out into the three lateral projections of the deutovum, the more distal portions of the legs being bent downward and forward into the leg sheaths.

Larva: After about six to seven days in the deutoval stage, ten or twelve days after egg laying, the fully formed larva emerges from the deutovum. Its activity begins by moving the legs, which can be seen through the translucent deutoval cuticula, back and forth in their sheaths. In a few hours it works its way free.

The body of the larva is red, the ocular areas deep red, the appendages pale. The newly hatched larva is about 0.19 to 0.2 mm. long.

The characters of the larva are shown in figure 1. Variations in the apparent positions of the apical abdominal setae are described in the portion of this paper entitled "Nomenclature." In addition there are actual variations in the positions of certain setae in unengorged individuals. Noticeable in this connection is the variation in the dorsal sublateral seta immediately behind the third transverse row of eight setae. On one or sometimes both sides of the body this seta often moves forward into the preceding row of setae, so that the dorsal setal formula becomes 2–8–8–9, etc., or 2–8–8–10, etc., instead of 2–8–8–8, etc. In one specimen studied there were nine instead of eight setae in the second row on the dorsum, and in another the same was true of the third row. The ventral abdominal setae often vary in number as well as position on the two sides of the body. The most

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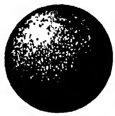
EXPLANATION OF PLATE III

(Figures 17 to 34 are all drawn to the same scale.)

Fig. 17, Egg of *Eutrombicula batatas*. Fig. 18, Dorsal view of deutovum partially covered by broken egg shell Fig. 19, Lateral view of same. Fig. 20, Dorsal view of deutovum with egg shell removed. Fig. 21, Lateral view of same. Fig. 22, Dorsal view of unengorged larva. Fig. 23, Lateral view of same. Fig. 24, Lateral view of engorged larva in position assumed prior to transformation. Fig. 25, Dorsal view of engorged larva. Fig. 26, Ventral view of protonymph. Fig. 27, Lateral view of same.



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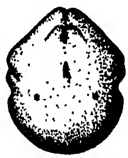

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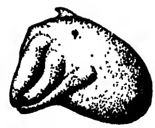

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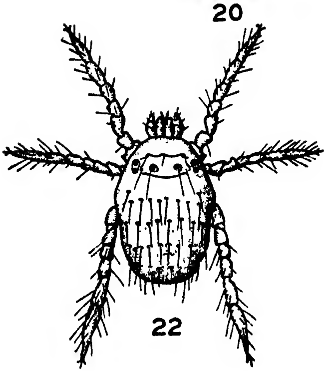

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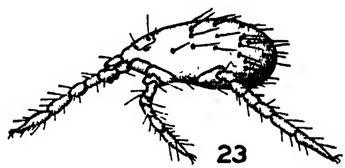

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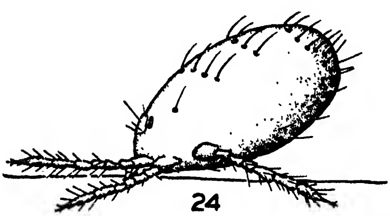

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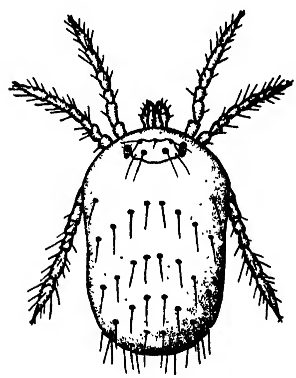

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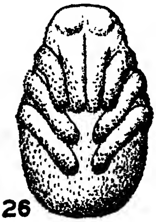

26

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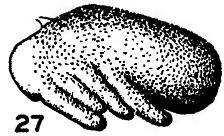


27

common variation of this sort is shown clearly by van Thiel (1930). Often there is one, or even two setae on one or sometimes both sides of the body in the vacant spaces midway between the anus and the seta marked "a" in figure 1. In one specimen the posterior sternal seta on one side of the body was absent.

The body setae appear more plumose than in the figure if the specimen is strongly compressed, since then the branches are pressed more nearly into the same plane.

The structure termed the "inner maxillary lobe" by Ewing (1944) is relatively small in most mounted specimens but under certain conditions is large and flat as shown in figure 1. It appears that when specimens are killed in Berlese mounting medium the lobes are large but when killed in alcohol and mounted later in the same medium the lobes are small.

Larvae can live in the laboratory for nearly two weeks without feeding. It may be that under natural conditions they would survive longer.

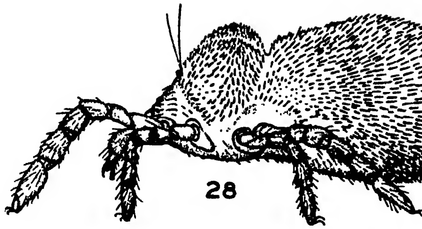
On finding a suitable host animal the larvae attach and engorge, reaching a length of 0.3 to 0.35 mm. Engorgement begins rather rapidly. On man specimens which have been attached only three hours are noticeably larger than unattached individuals. The length of time which chiggers remain attached to chickens varies from two to ten days. The great majority remain attached three or four days and only very few more than six days. After engorgement is complete the larvae drop from their host. They then crawl about actively for a period of time ranging from a few hours to four days, usually about one day. They then become quiescent, assuming the position shown in figure 24 with the legs commonly straight, the abdomen elevated, and the mouthparts serving to hold the mite in place. This usually takes place in nature in the bases of tufts of grass.

Soon after assuming this position the legs and mouthparts lose the power of movement, histolysis evidently taking place within them.

Protonymph: Within the body of the quiescent engorged larva the nymph develops, with its appendages folded up and completely independent of the larval appendages. Surrounding the developing nymph in the same manner that the deutoval integument surrounds the developing larva is a membrane which is considered by some to be the integument of the protonymph. This stage was called the nymphochrysalis by Miyajima and Okumura (1917) but according to Ewing (1944) is apparently homologous with the protonymph of many other mites. The word protonymph seems preferable to nymphochrysalis. The same membrane surrounding the developing nymph was termed the apoderm by Nagayo, Miyagawa, Mitamura, and Imamura (1917), who describe changes in its structure and the development of the nymphal appendages, the apoderma by Henking (1882) and the Zwischenhaut by Claparède (1868).

EXPLANATION OF PLATE IV

Fig. 28, Lateral view of newly emerged nymph of *Eutrombicula batatas*. Fig. 29, Ventral view of preadult. Fig. 30, Dorsal view of nymph. Fig. 31, Lateral view of preadult. Fig. 32, Lateral view of preadult within nymphal integument.



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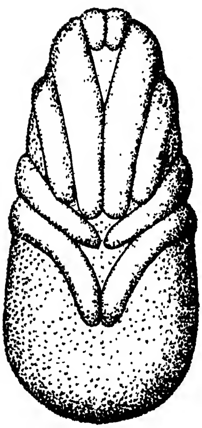
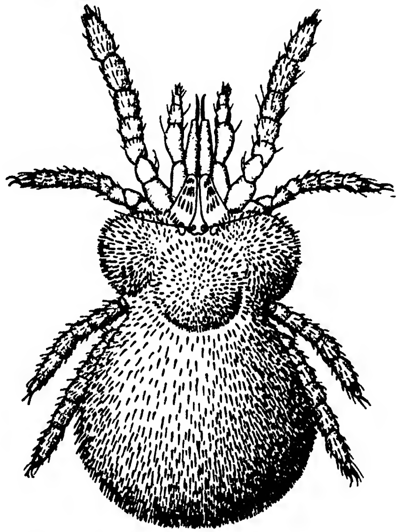


29

.1mm



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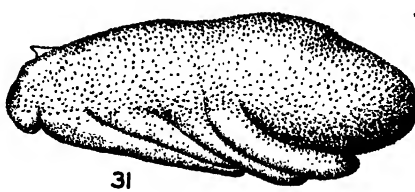

31

32

The protonymph (figures 26 and 27) never emerges from the larval integument, but must be dissected out before the emergence of the nymph. For a few days before emergence of the nymph, the protonymphal body shape and appendages may be seen through the tightly stretched larval integument, just as the preadult may be seen through the stretched nymphal integument (figure 32). The integument of the protonymph is minutely tuberculate. There is a dorsal spine, which according to Nagayo, Miyagawa, Mitamura, and Imamura (1917) is used to pierce the larval skin. The appendages are unsegmented and saclike. The nymphal appendages develop within those of the protonymph.

Nymph: The nymph emerges from the protonymphal and larval integuments through a transverse opening in the anterior part of the dorsum from five to seven days after the larva becomes quiescent. On first emerging the nymph seems very small and is dull red but within a few hours at most its body seems to swell and the body hairs become dry and fluffy, giving the characteristic brilliant red color as well as an appearance of larger size.

The nymph or first eight-legged stage closely resembles the adult except for its small size, and such characters as are shown in the illustrations. It is red, with pale legs. When compressed on a slide the constriction between anterior and posterior parts of the body is much less evident than in the figure. The length is about 0.5 mm. on emergence, increasing to 0.55 mm. or more after feeding. These measurements do not include the length of the posterior body hairs. The following characters will be helpful in identifying this species in the nymphal stage.

Pedipalps with few setae; claw-bearing segment with two curved, blunt spines on inner side; claw longer than the distance from its base to base of finger; base of claw produced ventrally to a sharp point; finger terminating in three or four simple, short, robust, curved setae. *Crista* rather thick posteriorly; pseudostigmatic area broader than long with a transverse ridge arcuate posteriorly; mesad of each pseudostigma is a longitudinal ridge which at its posterior end curves mesad and forms a projection on the posterior margin of the pseudostigmatic area. Pseudostigmatic organs longer than crista, with three to five short branches in distal halves. On each side of pseudostigmatic area is a smooth convex eye. *Body hairs* slightly longer posteriorly than on shoulders, arising from large disc-like papillae, somewhat elevated medially; these papillae are almost contiguous.

The duration of the nymphal stage was observed to vary from sixteen to forty-five days, probably depending largely on the availability of food. Only starved individuals lived as nymphs for as long as forty-five days. Others transformed in shorter periods.

There is apparently but one nymphal stage. Aside from the evidence provided by rather closely observed rearings of numerous individuals, this is shown by frequency curves based on measurements

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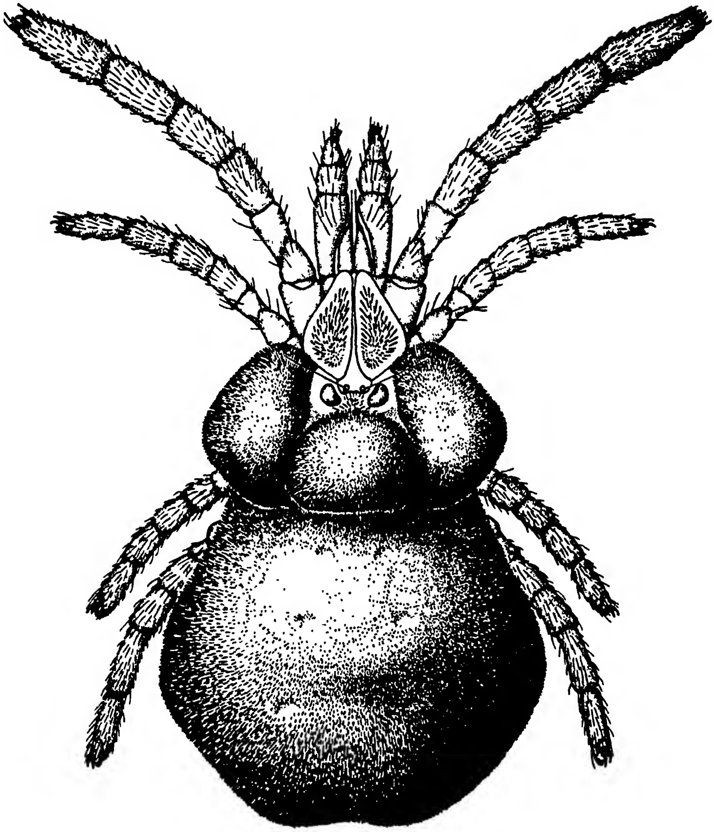
EXPLANATION OF PLATE V

Fig. 33, Dorsal view of large adult of *Eutrombicula batatas*. Fig. 34, Lateral view of same.



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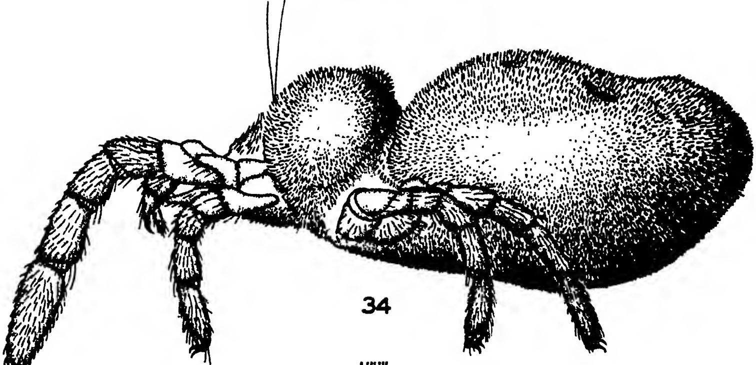

34

1mm

of portions of the appendages. Such curves are not bimodal for nymphs, nor are they for adults if the sexes are segregated. This is in contrast to certain other genera in the family (e. g., *Manriquia*) in which there are additional nymphal stages having most of the characters (e. g., six genital suckers) of the adult.

Preadult: When the nymph is ready to transform to the adult stage, it becomes quiescent and elongate in form, bloated in appearance. In nature this stage is ordinarily found hidden at the bases of tufts of grass, just beneath the soil surface, or inside broken pieces of hollow dead weed stems. Histolysis evidently takes place in the nymphal appendages, which become dry and brittle, and are easily broken off. Within the integument of the nymph is found the thin, tuberculate integument of the preadult, a stage which differs very little, except for larger size (0.55 to 0.66 mm. in length), from the protonymph and which never emerges from the nymphal integument. Through the stretched nymphal integument the form of the preadult can readily be seen (figure 32) and the dorsal spine of the preadult can often be seen to have ruptured the nymphal integument. The adult develops within the preadult integument, its appendages within those of the preadult. The preadult quiescent period lasts for five to seven days.

Adult: The adult emerges from the preadult and nymphal integuments through large rents in the dorsal surfaces.

The sexes are easily separated by the characters of the genitalia illustrated by Ewing (1944). The females average larger than the males. Females range from 0.77 to 0.99 mm. in length, the average of fifteen being 0.91 mm.; males range from 0.66 to 0.83 mm., the average of fifteen being 0.74 mm. A comparable difference in size, correlated with sex, was noted in the preadult stage. The body integument of adults, like that of nymphs, is soft and thin and can be stretched to some extent. The smaller adults are those which have recently become adult while larger ones have had some time for feeding. Adults are bright red with paler appendages.

Pedipalps with more setae than in nymph; inner surface of claw-bearing segment with three blunt spines arising near the base of the claw and an additional more pointed spine arising near the middle of the segment; base of claw with a blunt ventral projection; finger terminating in three or four short, robust, curved setae. *Crista* slender; pseudostigmatic area broader than long with a transverse curved ridge in front of the pseudostigmata, this ridge bending backward at its ends and extending posteriorly mesad of each pseudostigma to the posterior edge of the area; pseudostigmatic organs as long as crista, with two to eight short branches in the distal half. On each side of pseudostigmatic area is a smooth convex eye. *Body hairs* longer on posterior part of body than elsewhere, each arising from a disc-like papilla; apices of body hairs not thickened.

Adults have been kept alive in the laboratory for periods up to forty-five days. This is considerably less than for certain other species.

The food of nymphs and adults is not certainly known. They were not seen feeding, although considerable time was spent in watching for such action. Nymphs failed to grow and transform into adults, or did so only slowly and in very small numbers, in jars containing sterilized

soil alone, soil with grass or seedling corn growing in it, and soil to which was occasionally added small arthropods (other species of mites, Collembola, etc.), dead insects, small quantities of caterpillar feces, or pieces of potatoes. Nymphs grew well, however, in a mixture of five parts of sterilized soil and one part of chicken manure. Since much mould grows in such a mixture it was thought that the chiggers might be feeding on the fungus. However heat sterilization of the mixture greatly reduced the fungus growth, although it did not eliminate it entirely because of the spores carried on the bodies of the nymphal chiggers. The nymphs grew as well in such jars with reduced fungal content as in jars with much fungus.

From this evidence one may conclude that living animals, portions of living green plants (e. g., rootlets), as well as insect excreta and freshly dead animals and plants are not necessary for the growth of nymphs and adults of *E. batatas*. In all probability fungi are also unnecessary. Since the chiggers have sucking mouthparts, it seems probable that nymphs and adults of this species feed on soil moisture rich in organic matter, sucking such moisture from the interstices of damp soil.

The stages in the life history of *Eutrombicula batatas* are summarized in Table I. It is probable that the "intervening stages" should not

TABLE I

Major Stages	Intervening Stages	Characteristic Features	Duration
Egg		Spherical, laid singly on damp soil.	4–5 days
	deutovum	Quiescent, occurring within broken egg shell. With dorsal spine, unsegmented appendages, no setae.	6–7 days
Larva		Active, with six legs, and with setae on body and appendages.	Up to 14 days before feeding. 2–10 days on host. 1–4 days after leaving host.
	protonymph	Quiescent, occurring within dead larval integument. With dorsal spine, unsegmented appendages, no setae.	5–7 days
Nymph		Active, with eight legs, numerous plumose setae, 2 pairs of genital suckers.	16–45 days
	preadult	Quiescent, occurring within dead nymphal integument. With dorsal spine, unsegmented appendages, no setae.	5–7 days
Adult		Active, with eight legs, very numerous plumose setae, 3 pairs of genital suckers.	Up to 45 days

be considered as distinct stadia. The integument of the quiescent, pupalike stages evidently consists of a layer of hypodermal cells and a secreted cuticle which does not dissolve in caustic. It thus resembles the true integument of the active stages. However, in certain other mites of this family (e. g., ***Manriquia bequaerti*** Boshell and Kerr) there are at least four nymphal stages, each preceded by a protonymph. It thus seems that the formation of an extra integument is associated with each ecdysis and probably does not indicate the existence of another stadium.

The integuments of the intervening stages are delicate and not found as exuviae. According to Nagayo, Miyagawa, Mitamura and Imamura (1917) the integument of the protonymph undergoes "granular degeneration" shortly before emergence of the nymph.

It is probable that the life histories of other species are essentially similar. Apparently the preadult stage has not been previously described, but there can be little doubt that it exists in the species studied by Mayajima and Okumura (1917) for they describe the elongation of the nymph prior to transformation, just as it occurs in *batatas*, and the formation of the adult appendages within the nymphal body.

REARING METHODS

Since many unsuccessful attempts were made to rear this chigger before successful methods were devised, it seems worth while to record the methods finally used.

Fully engorged larvae were obtained in large numbers and in good condition by placing an infested chicken or other animal in a cage having a coarse wire mesh bottom. The cage was provided with short legs which supported it above the surface of the water in a large shallow tray. As the larvae fell from the chicken they landed in the water, floating helplessly on the surface.

Twice a day the chiggers were collected from the water surface onto small squares of paper, the mites sticking to the paper because of the surface tension of the water. Newspaper was found to have the proper absorptive qualities. As the squares of paper dry the mites are released and walk about.

The squares of paper with the mites on them were then placed in small fruit jars lined with a thin layer of plaster of Paris. The latter serves to absorb any moisture that condenses on its surface. This was important as many of the mites otherwise became stuck in condensed moisture on the glass, and died there.

After transformation to nymphs they were shaken out of the jars lined with plaster of Paris into rearing jars. The best type of rearing jar so far used is a medium sized fruit jar with the bottom removed and replaced by a plug of plaster of Paris. In the jar are then placed soil, sterilized or not according to the need, plants of grass, chicken manure, etc., to simulate the natural environment. Thus far chicken manure mixed with sterilized soil as described by Melvin has given the most rapid nymphal growth. The top of the jar is left open, and water is added daily or oftener. Excess water runs out through the plaster of Paris in the bottom of the jar. The mites are able to take up positions of favorable humidity for there is a gradient from relatively

dry above to very moist below. Evaporation from the soil surface and from the plaster keeps the temperature relatively low. Transformation to adults takes place readily in these jars, and egg laying takes place, particularly if the jars are kept at a temperature higher than usual for a few days. At times when larvae are expected to hatch a lid may be put on the jar.

Larvae were placed on the host animal by removing them from the jar by picking them up on wet pieces of paper. The paper was then placed in a very shallow, wide shell vial the open end of which was appressed closely to the skin of the animal and held in position with adhesive tape. As the paper dried slightly the mites were released from the water and attached themselves to the host.

A small plaster of Paris cell with a cover made of a microscope slide and held in place with a rubber band was found convenient for making special observations, as for example on eggs. Such cells have the advantage that water can be added from the outside through the plaster without disturbing the contents of the cells. Nymphs and adults, however, do not survive for more than a week or two in constant contact with plaster of Paris.

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SCIENCE AND THE PLANNED STATE, by JOHN R. BAKER. 120 pages. The Macmillan Company, 1945. Price $1.75.

This thoughtful little volume is from the pen of an English scientist, author of *The Scientific Life*, to which it is a sequel. It is evidently a result of dissatisfaction with wartime deference toward Soviet science, which appears to have been far more marked in Great Britain than in the United States.

The writer shows very vividly how scientific interest—even avocational scientific pursuits—have contributed not only to the development of scientific knowledge itself but also to the welfare of humanity in general. In this point his argument is tricky, for he disavows the need for practical applicability of scientific findings and yet repeatedly emphasizes the important uses to which purely scientific studies have sometimes been turned. On careful analysis his attitude is not in the least contradictory. He argues only that in a planned society the practical end would be sought, and only research toward practical ends would be encouraged, whereas many values have been found in the past in research for which no useful end could be foreseen. No doubt all scientists will agree with him that the right to pursue a spontaneous scientific interest, whether it shows evidence of practical value or not, is something to be guarded and cherished.

The book's comments on science in Soviet Russia and on the remarks of various writers on the relations of science to society and to politics are disturbing. It would be well for every scientist to read them as a suggestion of the impact of modern ideologies on the traditional freedom of his field. Evidently in Europe a considerable body of opinion would make scientific efforts primarily subservient to social benefits and to political expediency. Dr. Baker states the case beautifully in these words: "Many people today think of progress as meaning one thing only, the improvement of the material condition of the poorer members of the community. This is a limited outlook, for true progress means something more than material advancement. It means movement towards greater things in science, philosophy, art, music, literature, and all other branches of intellectual activity. That kind of progress is perfectly compatible with the securing of a square deal and a happy life for the common man, and conflict can only arise when the needs of the common man are made paramount." Whether the apparently inexorable march of social and political reform can be turned away from scientific fields remains to be seen, but certainly we in America should appreciate our advantages more keenly after reading Dr. Baker's documented statements, and should be better prepared to cope with future trends.—A. W. L.

STUDIES ON THE CRANE-FLIES OF MEXICO

PART VIII[1]

(Order Diptera, Superfamily Tipuloidea)

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In the present report I am describing various interesting crane-flies from Mexico, almost all received from my long-time friend and colleague, Dr. Alfons M. Dampf. These rich materials were chiefly captured by Dr. Dampf, with the assistance of certain of his co-workers and inspectors, as discussed under the individual species. I am very deeply obliged to Dr. Dampf for the privilege of retaining the type specimens of these novelties in my personal collection.

Tipula Linnaeus

Tipula (Trichotipula) religiosa sp. n.

General coloration of thorax opaque reddish brown, the praescutal stripes poorly differentiated against the ground; antennae with basal three segments yellow, the outer flagellar segments uniformly dark brown, with poorly defined basal enlargements; knobs of halteres dark brown; femora and tibiae yellow, their tips narrowly darkened; wings brownish yellow, the prearcular and costal fields, with vein *Cu*, light yellow; stigma pale brown; macrotrichia of outer cells of wing sparse; Sc_2 ending about opposite midlength of *Rs*, Sc_1 weakly preserved; *m* and petiole of cell M_1 subequal; abdomen yellow, the tergites with a brown median stripe; subterminal segments darkened; male hypopygium with the beak of the inner dististyle elongate, its apex obliquely truncate; lower beak well developed, separated from the beak by a broad U-shaped emargination.

Male.—Length about 14 mm.; wing, 13 mm.; antenna about 2.8 mm.

Female.—Length about 16 mm.; wing 14 mm.

Frontal prolongation of head brown to brownish yellow; nasus elongate; palpi brown. Antennae with basal three segments yellow; succeeding two or three segments brown, the outer ones dark brown; flagellar segments with basal enlargements poorly developed; verticils a little shorter than the segments. Head with center of vertex brownish gray, the front and orbits grayish white; vertical tubercle low, entire.

Pronotum brown, sparsely pruinose. Mesonotum opaque reddish brown, the praescututal stripes very poorly differentiated against the ground; intermediate stripes separated by a narrow to capillary darker brown median vitta, longer and heavier in female. Pleura and pleurotergite more testaceous yellow, sparsely pruinose; dorsopleural mem-

[1]The preceding part under this general title appeared in these ANNALS (Vol. XXXIII, 140–161, 1940). Contribution from the Entomological Laboratory, Massachusetts State College.

brane buffy yellow. Halteres with stem brown, narrowly more yellowed at base, knob dark brown. Legs with the coxae testaceous, sparsely pruinose; trochanters yellow; femora and tibiae yellow, the tips narrowly and weakly darkened; tarsi passing into black; claws (male) toothed. Wings with a strong brownish yellow suffusion, the prearcular and costal fields clear light yellow; stigma pale brown, a little darker than the ground; obliterative areas before stigma and across cell *1st* M_2; veins brown, the veins in the prearcular and costal fields, as well as *Cu*, yellow. Sparse macrotrichia in stigma and in cells R_3 to M_4, inclusive, somewhat more abundant in male. Venation: Sc_2 ending about opposite midlength of *Rs*, Sc_1 weakly preserved; *Rs* relatively long, oblique; R_{1+2} entire; inner end of cell *1st* M_2 pointed, lying basad of cell R_5; M_{3+4} short, subequal to *r-m*; *m* and petiole of cell M_1 subequal; *m-cu* on M_4 shortly beyond the perpendicular origin.

Abdominal tergites yellow, the second and succeeding segments with a brown median stripe, slightly more interrupted on the narrow glabrous basal rings; sternites yellow; subterminal segments more infuscated to form a more or less distinct subterminal ring; hypopygium yellow. Male hypopygium with the caudal margin of tergite with a deep V-shaped notch, the broad lateral lobes obtusely rounded; notch and mesal edge of lobes margined with retrorse blackened spinous setae. Outer dististyle dusky, moderately broad, the tip obtuse. Inner dististyle with the beak elongate, its apex obliquely truncate, the lower angle more acute and blackened; lower beak widely separated from the beak by a broad U-shaped emargination, blackened and continued across the face of style as a narrow flange; face of style near this produced portion with a small darkened lobe; dorsal crest of style with numerous relatively short black spinous setae and abundant erect long yellow bristles.

HABITAT: Mexico D. F., 1921 (received through an exchange with Dr. William G. Dietz). *Holotype* ♂ and *Allotype* ♀.

The only near regional ally is *Tipula* (*Trichotipula*) *aplecta* Alexander, which is entirely different in the coloration of the body and wings, and, especially, in the structure of the male hypopygium, particularly the very reduced inner dististyle.

Limonia Meigen

Limonia (Limonia) tragica sp. n.

General coloration black, including most of the thoracic notum and pleura; anterior vertex reduced to a narrow strip; halteres black, the base of stem restrictedly pale; wings with a brownish tinge, conspicuously patterned with dark brown; Sc_1 ending about opposite three-fourths the length of *Rs* which is square at origin; cell *1st* M_2 longer than vein M_{1+2} beyond it; *m-cu* close to fork of *M*, longer than the distal section of Cu_1; abdomen black.

Female.—Length about 8 mm.; wing, 8.5 mm.

Rostrum and palpi black. Antennae with scape and pedicel black; flagellum broken. Head black, sparsely pruinose; anterior vertex reduced to a linear strip, at narrowest point only about as wide as two rows of ommatidia.

Pronotum broken. Mesonotal praescutum chiefly blackened, the central portion more reddish or piceous but not forming an evident stripe; lateral pretergites and margin of praescutum conspicuously light yellow; scutal lobes blackened, the centers slightly more grayish; median region of scutum narrowly more yellow pollinose; scutellum dark, brownish yellow pollinose; mediotergite with the central portion gray pruinose, the cephalic lateral angles restrictedly obscure yellow; pleurotergite black, sparsely pruinose. Pleura almost entirely black, with a slightly paler ventral stripe that extends from behind the fore coxae to the pteropleurite. Halteres black, the base of stem restrictedly pale. Legs with the fore and middle coxae darkened basally, the tips reddened, the posterior coxae more uniformly reddened; trochanters reddish yellow; remainder of legs broken. Wings relatively broad, with a brownish tinge, especially in the basal and costal portions; a conspicuous dark brown pattern, as follows: Origin of *Rs*; fork of *Sc*; the short-oval stigma; seams over cord and outer end of cell *1st* M_2; outer radial field, especially the outer ends of cells R_2 and R_3; cells R_5 to M_3 less evidently darkened before their outer ends, the tips pale; more or less distinct seams to some of the veins, including *Cu*; veins brown, *Sc* and *R* paler. No stigmal trichia. Venation: Sc_1 ending about opposite three-fourths *Rs*, Sc_2 at tip; *Rs* square at origin; R_2 and R_{1+2} in transverse alignment; inner end of cell *1st* M_2 arcuated; cell *1st* M_2 longer than vein M_{1+2} beyond it; *m-cu* close to fork of *M*, about one-third longer than the distal section of Cu_1; cell *2nd A* relatively wide.

Abdomen black, the caudal borders of the intermediate sternites narrowly obscure yellow; eighth sternite obscure yellow, more or less darkened medially at base. Genital shield of ovipositor dark brown; cerci slender, upcurved to the acute tips; hypovalvae strong, blackened basally.

HABITAT: Mexico (Chiapas). *Holotype*, ♀, Finca Prusia, altitude 1,250 meters, December 4, 1932 (A. M. Dampf); M. F. 2839.

This very distinct species is readily told from the most similar regional forms, such as *Limonia* (*Limonia*) *caribaea* Alexander, *L.* (*L.*) *horrenda* Alexander, and *L.* (*L.*) *hyperphallus* Alexander, by the coloration of the body and the pattern and venation of the wings. All of these flies have conspicuously patterned wings but with no dark areas basad of the level of the origin of the cord.

Dicranota Zetterstedt

Dicranota (Rhaphidolabis) mexicana sp. n.

General coloration gray, the praescutum with three conspicuous dark brown stripes; antennae 13-segmented, black throughout; halteres with knobs dark brown; legs dark brown; wings subhyaline, with a conspicuous dark brown stigma; veins beyond cord of unusual length, the distal section of R_5 subequal to or longer than Sc_1; abdominal tergites dark reddish brown, the sternites more pruinose; male hypopygium with the lateral tergal arms appearing as relatively slender glabrous blades; apical lobe of basistyle and the outer dististyle with conspicuous blackened spines; gonaphyses unusually broad and expanded.

Male.—Length about 6 mm.; wing, 7 mm.

Female.—Length about 6.5 mm.; wing, 7.5 mm.

Rostrum gray; palpi black. Antennae 13-segmented, black throughout; flagellar segments oval, the first about one-third longer than the second. Head brownish gray, clearer gray behind.

Pronotum gray, broadly but weakly infuscated medially. Mesonotal praescutum gray, with three conspicuous dark brown stripes, the median one broad and conspicuous, the laterals narrow and poorly indicated; posterior sclerites of notum gray, the centers of the scutal lobes only slightly darkened; thorax unusually high and gibbous, especially the praescutum. Pleura light gray, variegated with darker gray. Halteres with stem yellow, knob dark brown. Legs with the coxae reddish, gray pruinose; trochanters brownish yellow; remainder of legs dark brown. Wings subhyaline, the extreme base more yellowed; stigma oval, dark brown, conspicuous; veins dark brown, those at wing base more brightened. Venation: *Rs* gently arcuated; R_{2+3+4} preserved, exceeding *r-m*; veins beyond cord of unusual length, the distal section of R_5 subequal to or longer than Sc_1; cell M_1 present.

Abdominal tergites dark reddish brown, unpatterned; sternites and outer tergites more pruinose; cerci elongate, yellowish horn color, restrictedly darkened basally. Male hypopygium with the median tergal lobe entire, moderately broad, its apex obtuse, provided with about a score of strong spinous setae; lateral tergal arms appearing as long, relatively slender, glabrous blades, very gradually narrowed to the stout subacute tips. Interbases appearing as shorter and broader flattened glabrous blades, the apex truncated, the lateral angle produced into a short strong spinous point. Basistyle with a group of long conspicuous setae on mesal face; apical lobe of basistyle relatively short and stout, provided with about a score of blackened spines. Outer dististyle expanded outwardly, the obliquely truncated apex provided with more than 30 blackened spines. Inner dististyle longer than the outer, the basal half broad, the distal portion much narrower, its apex obtuse; surface of style with numerous setae of various lengths. Phallosome with the gonapophyses unusually broad and expanded, the margins rounded, the surface with abundant delicate setulae.

HABITAT: Mexico (Mexico State and Federal District). *Holotype*, ♂, Dos Rios, Mexico State, altitude 2,500 meters, April 20, 1937 (A. M. Dampf); M. B. 222. *Allotype*, ♀, Desierta de los leones, Federal District, March 29, 1925 (A. M. Dampf); M. F. 520.

The closest described relative of the present fly appears to be *Dicranota* (*Rhaphidolabis*) *neomexicana* (Alexander), of the southern and central Rocky Mountains. The present fly has the wings longer and narrower, especially the veins and cells beyond the cord, and with the praescutum conspicuously trivittate with dark brown. The structure of the male hypopygium is entirely different in the two species. This is the first record of occurrence of the subgenus in America south of the Mexican border.

Dicranota (Rhaphidolabis) rostrifera sp. n.

General coloration dark gray; wings subhyaline, the stigma medium brown; R_{2+3+4} distinct, at least one-half longer than the basal section

of R_5; male hypopygium with the lateral tergal arms appearing as glabrous blades that narrow to a terminal spine; interbase appearing as a flattened blade that is expanded outwardly and here produced laterad into a beaklike spine, the apex of the blade with microscopic setulae; gonapophyses narrow, with from six to eight pale oval punctures before apex.

Male.—Length about 5.8–6 mm.; wing, 6.5–7 mm.

Female.—Length about 6.8 –7 mm.; wing, 7.5–7.8 mm.

Rostrum and palpi black. Antennae 12-segmented, black throughout; flagellar segments oval, the terminal one about one-half longer than the penultimate. Head above dark gray.

Thorax light gray, the praescutum with three brown stripes, the median one broad; centers of scutal lobes darkened. Halteres with stem obscure yellow, knob darkened. Legs with the coxae gray; trochanters brown; remainder of legs dark brown, the tarsi a little paler. Wings subhyaline, the stigma medium brown, relatively distinct; veins brown. Venation: *Rs* arcuated; R_{2+3+4} distinct, variable in length but at least one-half longer than basal section of R_5, in cases up to three times as long; R_{1+2} and R_2 subequal in length or the latter longer; cell M_1 usually present, lacking in the paratype; *m-cu* from one-third to one-fourth its length beyond the fork of *M*.

Abdomen dark brown, the sternites somewhat brightened; hypopygium dark brown. Male hypopygium with the median region of tergite low and obtuse, much lower than in ***mexicana***; lateral tergal arms appearing as conspicuous glabrous blades, broad at base, narrowed and strongly curved to a long terminal spine; posterior border of tergite near bases of lateral arms with a group of about a dozen long setae. Interbases of distinctive shape, appearing as flattened blades, expanded at distal end into a subcircular blade, one end of which is produced laterad into a long straight spine, whence the specific name; stem with about four long erect setae from conspicuous punctures; outer portion of expanded blade with microscopic setulae that are directed toward the beak, producing a roughened appearance, in cases these setulae more abundant and conspicuous than in others. Apex of basistyle broadly obtuse, armed with four or five pale spinous points. Outer dististyle relatively narrow, parallel-sided, the apex obtuse, provided with more than a score of spines. Inner dististyle large and conspicuous, expanded outwardly, provided with setae that are longest toward the apex of the beak. Phallosome with the subtending apophyses very narrow, the obtuse tips with microscopic setulae, the outer portion of each blade with about six to eight oval pale punctures.

HABITAT: Mexico (Mexico State and Federal District). ***Holotype***, ♂, among aquatic plants from Rio Borja, D. F., February 9, 1932 (A. M. Dampf); No. 62–32. ***Allotopotype***, ♀. ***Paratopotypes***, 6 ♂ ♀; ***paratype***, ♂, Dos Rios, Mexico State, altitude 2,500 meters, April 20, 1937 (A. M. Dampf); M. B. 222. The paratype was associated with ***Antocha (Antocha) monticola*** Alexander and ***Dicranota (Rhaphidolabis) mexicana*** sp. n.

Dicranota (Rhaphidolabis) rostrifera is quite distinct from all other regional members of the genus, differing especially in the structure of the male hypopygium. The most similar of these species are D. (*R.*) ***mexicana*** sp. n. and *D.* (*R.*) ***neomexicana*** (Alexander).

Oxydiscus de Meijere

Oxydiscus (Oxydiscus) oaxacensis sp. n.

General coloration brownish black, only slightly variegated with brighter; halteres dusky, the knob and base of stem obscure yellow; wings relatively broad, grayish yellow, with a restricted but conspicuous dark brown pattern; cell M_1 present; *m-cu* about one-half to two-thirds its own length beyond the fork of *M;* male hypopygium with the marginal spine of the outer dististyle unusually long and slender.

Male.—Length about 4 mm.; wing, 5 mm.

Female.—Length about 4 mm.; wing, 4 mm.

Rostrum and palpi brownish black. Antennae with basal segments brownish yellow, the flagellar segments subcylindrical, darker brown. Head dark brown.

Prothorax and mesothorax almost uniformly brownish black, the praescutum a little more variegated with paler, especially at and before the suture. Halteres dusky yellow, the base of stem and apex of knob more brightened. Legs with the coxae brownish black; trochanters obscure yellow; remainder of legs broken. Wings relatively broad, widest opposite origin of *Rs;* grayish yellow, the prearcular and costal fields somewhat clearer yellow; a restricted but conspicuous dark brown pattern, including marks at origin of *Rs*, R_2, cord and outer end of cell *1st* M_2, and fork of M_{1+2}; stigma paler brown, confluent with the darkened seam over R_2; veins brown. Macrotrichia of cells relatively sparse, in outer ends of cells R_3 to *2nd* M_2, inclusive; stigmal trichia present. Venation: Sc_1 ending just beyond fork of *Rs*, Sc_2 a short distance from its tip, Sc_1 alone about equal to *m-cu; Rs* strongly arcuated at origin; R_2 close to fork of R_{2+3+4}; inner ends of cells R_3, R_5 and *1st* M_2 in transverse alignment; cell M_1 about two-thirds its petiole; cell *1st* M_2 strongly widened outwardly; *m-cu* about one-half to two-thirds its length beyond the fork of *M*.

Abdominal tergites brownish black; central portion of sternites somewhat paler brown; hypopygium paler yellow. Male hypopygium with the outer dististyle at apex bearing two conspicuous teeth, with a few microscopic denticles in the axil of the lower or larger spine; a further long straight spine on lower margin at near two-thirds the length. Aedeagus with ventral spines divergent, pale, especially on outer half, slightly bulbous just before the short acute tips.

HABITAT: Mexico (Oaxaca). *Holotype*, ♂, Yotao, Sierra de Juarez, September 15, 1935 (Fr. Reyes); Dampf M. F. 6241. *Allotype*, ♀, Yaxè, Sierra de Juarez, altitude 1,450 meters, August 10, 1935 (A. Tort); Dampf M. F. 6139. *Paratopotype*, 1 ♂, pinned with type.

This fly is readily told from all other described New World species of the genus by the patterned wings.

Shannonomyia Alexander

Shannonomyia protuberans sp. n.

General coloration clear light gray, the praescutum unpatterned; antennae brownish black throughout, flagellar segments suboval, with the lower face slightly more bulging or protuberant than the upper;

wings brownish yellow, stigma oval, very pale brown; cell *1*st M_2 small, about two-thirds as long as vein M_4; male hypopygium with the outer dististyle slender, the apex blackened, unequally bifid; gonapophyses appearing as relatively long, strongly curved hooks.

Male.—Length about 6.5 mm.; wing, 7 mm.; antenna about 2 mm.

Rostrum light gray pruinose; palpi black. Antennae moderately ong, brownish black; flagellar segments suboval, with the lower face slightly more bulging or protuberant than the upper one; verticils shorter than the segments; terminal segment a little more than one-half the penultimate and much smaller. Head gray; posterior vertex with a vague capillary darkened line; anterior vertex broad, exceeding four times the diameter of the scape.

Thorax almost uniformly clear light gray, the praescutum without pattern. Halteres with stem pale, knob weakly infuscated. Legs with the coxae and trochanters obscure yellow, the former sparsely pruinose; remainder of legs broken. Wings with a brownish yellow suffusion, the base somewhat clearer yellow; stigma oval, very pale brown, scarcely evident against the ground; veins brown, more yellowed in the brightened portions. Venation: Sc_2 at extreme tip of Sc_1, the latter ending a short distance before fork of *Rs*, this being about one-half longer than R_{2+3+4}; R_2 at fork of R_{2+3+4}, the tip of R_{1+2} atrophied; cell *1st* M_2 unusually small, about two-thirds vein M_4; *m-cu* about one-half to two-thirds its length beyond the fork of *M*.

Abdomen dark gray throughout. Male hypopygium with the outer dististyle slender, the outer third blackened with the apex unequally bifid. Inner dististyle only about three-fifths as long, gradually narrowed outwardly, the outer surface with abundant retrorse setae. Each gonapophysis appearing as a relatively long, strongly curved hook. Aedeagus relatively small.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Lagunas de Zempole, altitude 2,800 meters, September 2, 1937, in open pine forest, swept from grasses and *Alnus* foliage between boulders on rocky hills (A. M. Dampf); M. F. 6189.

Shannonomyia protuberans is undoubtedly closely related to *S. ovaliformis* Alexander, from which it differs in the details of structure of the antennae and male hypopygium, particularly the gonapophyses.

Shannonomyia lenitatis sp. n.

General coloration dark gray, the praescutum virtually unpatterned; antennae (male) moderately long, about one-fourth the length of body, the flagellar segments with protuberant lower faces; halteres with infuscated knobs; legs brownish yellow, the tips of femora, tibiae and basitarsi narrowly darkened; wings with costal border weakly infuscated; stigma brown, conspicuous; cell M_2 open by the atrophy of the basal section of M_3; male hypopygium with the gonapophyses appearing as long, strongly curved spines.

Male.—Length about 6.2–6.3 mm.; wing, 6.8–7 mm.; antenna about 1.6–1.7 mm.

Female.—Length about 6.5 mm.; wing, 6.8 mm.

Rostrum gray; palpi black. Antennae brownish black tnroughout, relatively elongate; flagellar segments (male) suboval, with the ventral

face more bulging, the outer segments longer and more slender; segments with a dense erect pubescence; longest verticils unilaterally distributed, subequal in length to the segments. Head dark gray.

Thorax almost uniformly dark gray, the praescutum virtually unpatterned, pronotal scutellum a little paler brown. Halteres with stem obscure yellow, knob infuscated. Legs with coxae infuscated, pruinose; trochanters obscure yellow; femora brownish yellow, clearer yellow basally, the tips more infuscated; tibiae and basitarsi obscure yellow, the tips darkened; remainder of tarsi black. Wings with the costal border, anterior cord and vein *Cu* weakly darkened; outer cells of wing even less evidently infuscated; stigma darker brown, oval, conspicuous; remainder of wing whitish subhyaline; veins brown. No macrotrichia in cells of wing. Venation: Sc_1 ending about opposite four-fifths *Rs*, Sc_2 near its tip; *Rs* rather strongly arcuated at origin; R_{2+3+4} unusually short, only about one-third to two-thirds longer than the basal section of R_5; cell M_2 open by the basal section of M_3 being atrophied; *m-cu* about one-third to one-half its length beyond the fork of *M*.

Abdomen, including hypopygium, brownish black. Male hypopygium with the outer dististyle narrowed and heavily blackened on outer third, the tip conspicuously bidentate; outer surface at base with a low cushion that is provided with abundant long setae. Inner dististyle shorter, darkened, gently curved, the outer margin with a row of erect to slightly retrorse setae. Gonapophyses appearing as long, slender, very strongly curved spines, gradually narrowed to the acute tips. Aedeagus relatively small and slender, the base with the enclosed penis sinuous.

HABITAT: Mexico (Chiapas). *Holotype*, ♂, Sierra Madre, altitude 2,000 meters, December 6, 1932 (A. M. Dampf); M. F. 2875. *Allotopotype*, a fragmentary ♀, pinned with type. *Paratype*, 1 ♂, Finca Prusia, altitude 1,440–1,780 meters, December 6, 1932 (A. M. Dampf); M. F. 2872.

Among the various species of the genus that have cell M_2 of the wings open, ***Shannonomyia myersiana*** Alexander, *S. **orophila*** Alexander, and *S. **triangularis*** Alexander have this open by the atrophy of *m* rather than the basal section of M_3, as in the present fly. The only other described species having the cell open in the latter manner is *S. **cerbereana*** Alexander, which is readily told by the strongly darkened wings and the presence of numerous macrotrichia in the outer cells.

Atarba Osten Sacken

Atarba (Atarba) religiosa sp. n.

Allied to ***mexicana;*** general coloration of mesonotum brown, more or less pruinose, scutellum more brightened; antennae (male) elongate, more than one-half the length of wing, scape and pedicel yellow, flagellum black; femora infuscated, their bases restrictedly more yellowed; tibiae brownish yellow, the tips narrowly infuscated; wings with a very pale yellowish suffusion, the stigma scarcely indicated; *Sc* long, Sc_1 ending about opposite midlength of the long *Rs;* cell *1st* M_2 rectangular, approximately one-half the distal section of vein M_3; *m-cu* nearly opposite midlength of cell *1st* M_2; abdomen brown, with a still darker brown sub-

terminal ring, hypopygium yellow; male hypopygium with the lateral angles of the appendage of the ninth sternite acute; spines of outer dististyle grouped at and near apex; inner dististyle truncated at tip, the upper apical angle more produced; gonapophysis with abundant appressed spines; aedeagus long and sinuous.

Male.—Length about 6.5 mm.; wing, 6.8 mm.; antenna about 4 mm.

Rostrum yellow; palpi dark brown. Antennae (male) elongate; scape and pedicel light yellow, flagellum black; flagellar segments long-cylindrical, with scattered elongate verticils on the upper face, the longest less than one-half the segments; an additional erect pale pubescence that is about one-third as long. Head brownish gray.

Pronotum and mesonotum chiefly brown, more or less pruinose, the scutellum more brightened, obscure yellow; lateral borders of praescutum and adjoining portion of the pronotum darker brown. Pleura chiefly reddish brown, more or less pruinose. Halteres with stem obscure yellow, knob infuscated. Legs with the coxae brownish yellow, sparsely pruinose; trochanters yellow; femora infuscated, the bases restrictedly more yellowed; tibiae brownish yellow, the tips narrowly but conspicuously infuscated; proximal tarsal segments obscure yellow, the outer segments more infuscated. Wings with a very pale yellow suffusion, the stigma scarcely indicated; a narrow and vague darkened seam along cord, shown especially by a slight darkening of the pale brown veins; veins of the prearcular field more yellowed. Venation: Sc_1 ending about opposite midlength of *Rs*, Sc_2 some distance from its tip, Sc_1 a little shorter than *m-cu; Rs* elongate, nearly three times *m-cu;* branches of *Rs* diverging very gradually from one another, cell R_3 at margin a trifle wider than at midlength; cell *1st* M_2 rectangular, approximately one-half the distal section of vein M_3; *m-cu* nearly opposite midlength of cell *1st* M_2.

Abdomen brown, with a still darker brown subterminal ring; hypopygium, excepting the blackened outer dististyle, yellow. Male hypopygium with the appendage of the ninth sternite conspicuously emarginate at apex, each outer lateral angle extended into an acute point. Outer dististyle straight, terminating in a strong spine, with about seven or eight smaller spines on the outer face near apex, the outermost largest; a few smaller spinules on ventral face at base of the terminal spine. Inner dististyle subequal in length, truncated at apex, the upper apical angle somewhat produced into a point, the lower angle less evidently so. Gonapophyses covered with abundant appressed spines, the outer ones larger and more conspicuous. Aedeagus long and sinuous, the extreme apex expanded, the lower margin with pale membrane that is more dilated at near midlength of the organ.

HABITAT: Mexico (Federal District). *Holotype*, ♂, Desierto de los leones, August 24, 1930 (A. M. Dampf); M. F. 1744.

Atarba (*Atarba*) *religiosa* is readily told from *A.* (*A.*) *mexicana* Alexander, the only allied regional species so far described, by the coloration of the body, legs and wings, the details of venation, and the structure of the male hypopygium.

Teucholabis Osten Sacken

Teucholabis (Teucholabis) nigroclavaria sp. n.

Allied to *pabulatoria;* size small (wing, male, less than 3.5 mm.); rostrum reddish, head above gray pruinose; mesonotal praescutum with the disk dark liver brown, the lateral borders light yellow; thoracic pleura with a conspicuous silvery stripe; halteres dark brown; femora yellow, the tips conspicuously blackened; wings whitish subhyaline, the stigma exceedingly reduced; Sc_1 ending just before origin of *Rs*; abdominal tergites bicolored, dark brown, the posterior borders yellow, hypopygium black; male hypopygium with the basistyle produced caudad into a stout lobe but with no spines; outer dististyle a short blackened club, the apex and outer margin with appressed spinules; aedeagus compressed-flattened on outer half.

Male.—Length about 3.5 mm.; wing, 3.3 mm.

Rostrum reddish; palpi dark brown. Antennae black throughout, the scape more pruinose; flagellar segments oval. Head dark, heavily gray pruinose, the occipital region restrictedly reddened; eyes large.

Pronotum dark brown; pretergites yellow. Mesonotal praescutum with the disk dark liver brown, the humeral and lateral portions light yellow; scutal lobes similarly liver brown; scutellum and posterior borders of scutal lobes yellow, parascutella darkened; mediotergite with central portion dark brown, the lateral margins and the pleurotergite more reddish brown. Pleura chiefly dark brown, with a diffuse but conspicuous more silvery longitudinal stripe extending from behind the fore coxae to the base of abdomen, passing beneath the root of the halteres. Halteres dark brown. Legs with the coxae reddish brown; trochanters yellow; femora yellow, the tips rather narrowly but conspicuously blackened, subequal on all legs and including the distal seventh or eighth; tibiae and basitarsi yellow, the tips narrowly darkened; remainder of tarsi black. Wings whitish subhyaline, the prearcular field a trifle more yellowed; stigma exceedingly reduced, appearing as a slight seam lying chiefly distad of vein R_2; veins brown, the prearcular veins and outer portion of *C* more yellowed. Venation: *Sc* very short, Sc_1 ending just before the origin of *Rs*, Sc_2 only a short distance from its tip; *Rs* longer than its anterior branch, the latter diverging strongly from R_5 so cell R_3 at margin is very extensive, about three times cell R_2; vein R_2 just beyond the fork of *Rs;* cell *1st* M_2 narrow, subrectangular, only slightly widened outwardly, subequal in length to the distal section of vein M_3; *m-cu* about one-fourth to one-fifth its length beyond the fork of *M;* cell *2nd A* relatively narrow, the posterior margin of wing inshirred opposite the end of vein *2nd A*.

Abdominal tergites bicolored, chiefly dark brown, the posterior borders yellow, a little more extensive at the outer angles; sternites and subterminal segments more uniformly yellow; hypopygium conspicuously and abruptly blackened. Sternal pocket nearly circular in outline, at the posterior portion of sternite five, comprised of about 75 small tubercles, each tipped with a long black seta. Male hypopygium of unusually simple structure. Basistyle at apex produced into a stout lobe that bears several long setae but no spines; mesal edge of style with a long low blackened flange. Outer dististyle a short, entirely

blackened club, the apex and outer margin almost back to the base with conspicuous appressed spinules. Inner dististyle with the apical portion unusually long and narrow, bladelike, the lower or more basal tooth very obtuse; lobe near base of style with about four strong setae. Aedeagus compressed-flattened, the outer half suboval in outline, produced into a strong subapical spine; surface of blade, and especially the margins, with elongate yellow setae, those of the disk shorter and more sparse.

HABITAT: Mexico (Chiapas). *Holotype*, ♂, Zapote, November 12, 1930 (A. M. Dampf); M. F. 1821.

The most similar described species are *Teucholabis* (*Teucholabis*) *minuta* Alexander and *T.* (*T.*) *pabulatoria* Alexander, of Mexico and Guatemala, which are likewise among the smallest known members of the genus. The present fly differs especially in the structure of the male hypopygium, particularly the short blackened outer dististyle and the inner dististyle. The lack of a spine or spinous blade on the basistyle is exceedingly uncommon in this great genus but is a character of all three species here mentioned.

Gonomyia Meigen

Gonomyia (Gonomyia) megarhopala sp. n.

General coloration dark gray, the praescutum with three brown stripes; rostrum and antennae black; halteres elongate, stem yellow, knob infuscated; wings relatively narrow, strongly tinged with brown; *m-cu* close to the fork of *M;* male hypopygium with the outer dististyle a very conspicuous clavate dark-colored structure having a slender pale stem; spines of aedeagus weak, straight.

Male.—Length about 6 mm.; wing, 7 mm.

Female.—Length about 6.5 mm.; wing, 7 mm.

Rostrum and palpi black. Antennae black throughout, relatively long; flagellar segments elongate-oval, longer than the verticils; a dense pale pubescence on flagellum. Head gray.

Pronotum dark brownish gray, restrictedly obscure yellow on sides; pretergites pale yellow. Mesonotum gray, the praescutum with three brown stripes, the scutal lobes with brownish centers; posterior-lateral portions of scutal lobes yellow; scutellum brownish gray, the posterior border reddish yellow; postnotum gray. Pleura obscure yellow, conspicuously striped with gray, the more dorsal stripe extending from the cervical region across the propleura and anepisternum to the pteropleurite; lower stripe occupying the ventral sternopleurite and meral region; posterior sclerites, including the pteropleurite, metapleura and most of the pleurotergite of the yellow ground. Halteres elongate, stem yellow, knob dark brown. Legs with the coxae gray pruinose, the tips paling to yellow; trochanters obscure brownish yellow; remainder of legs broken. Wings relatively narrow, with a strong brownish tinge, the oval stigma brown; veins dark brown. Venation: *Sc* relatively short, Sc_1 ending about opposite one-fifth to one-sixth *Rs*, Sc_2 at its extreme tip; vein R_4 at apex deflected strongly toward the wing apex, cell R_3 at margin correspondingly wide; basal section of R_5 reduced; cell *1st* M_2 shorter than the veins beyond it; *m-cu* close to the fork of *M*.

Abdomen brownish gray, the caudal and lateral borders of the intermediate tergites narrowly yellow; sternites more uniformly dark brown. Male hypopygium with the apical lobe of the basistyle relatively small, subequal in length to the inner dististyle. Outer dististyle a very long slender-stemmed club, nearly three times as long as the lobe of the basistyle, the expanded portion darkened, the stem pale; club more or less truncated at apex, provided with conspicuous setae except along the outer border. Inner dististyle with a slender curved blackened spine and a shorter, more fleshy body that bears the usual fasciculate setae, these separate at origins, the outermost from a tuberculate base. Aedeagus a simple darkened blade, its apex a decurved point; subtending spines unusually small and weak, straight, slightly unequal in size.

HABITAT: Mexico (Morelos and Mexico State). *Holotype*, ♂, Lagunas de Zempole, Morelos, altitude 2,800 meters, September 2, 1937, in open pine forest, swept from grasses and *Alnus* foliage between boulders on rocky hills (A. M. Dampf); M. F. 6189. *Paratype*, a broken ♀, Ajusco, Mexico State, altitude 3,500 meters, May 10, 1925 (A. M. Dampf); M. F. 549.

Gonomyia (*Gonomyia*) *megarhopala* is very distinct from other regional species, especially in the structure of the male hypopygium. In the latter regard, it somewhat suggests the more northern *G.* (*G.*) *filicauda* Alexander but is entirely distinct.

Gonomyia (Gonomyia) bifurcula sp. n.

Allied to *bifurcifer;* general coloration of mesonotum dark brown, the scutellum obscure yellow; pleura and pleurotergite brownish yellow or light brown; wings with a weak brownish tinge, stigma scarcely indicated; R_{2+3+4} a little longer than *Rs*, the latter in longitudinal alignment with R_5; *m-cu* at near one-third the length of cell *1st* M_2; male hypopygium with the two dististyles terminal in position, the inner style profoundly bifid; outer dististyle slender, microscopically denticulate on outer face at near midlength; phallosome terminating in two blackened, unequal spines.

Male.—Length about 4.5 mm.; wing, 5 mm.

Head broken. Pronotum infuscated; pretergites obscure brownish yellow. Mesonotal praescutum and scutum very dark brown, the surface sparsely pruinose; praescutal borders paler brown; scutellum chiefly obscure yellow, the base restrictedly darkened; mediotergite dark brown, sparsely pruinose; pleurotergite brownish yellow. Pleura light brown, the dorsopleural membrane more yellowed. Halteres relatively long, brownish black, the base of stem narrowly yellow. Legs with the coxae yellowish brown, trochanters darker; remainder of legs broken. Wings with a weak brownish tinge, the prearcular field paler; stigma scarcely indicated; veins brown. Venation: Sc_1 ending opposite origin of *Rs*, the latter shorter than R_{2+3+4} which is strongly arcuated at origin; *Rs* in alignment with R_5; R_4 about three times R_3; cell *1st* M_2 long, slightly widened outwardly, subequal in length to vein M_4 beyond it; *m-cu* about its own length beyond the fork of *M* or at near one-third the length of cell *1st* M_2.

Abdomen brown, the hypopygium more yellowish brown. Male

hypopygium with the two dististyles terminal in position, the outer style a long sinuous blackened blade, its central third somewhat more dilated and with microscopic appressed denticles on the outer margin; outer third or more narrowed into a flattened blade, its tip acute. Inner dististyle bifid, the shorter arm blackened, expanded at tip into a scabrous head, including one larger denticle; inner arm elongate, terminating in two fasciculate setae of unusual length, approximately as long as the arm itself, terminal in position. Phallosome consisting of a blackened central structure, forking into two unequal blackened spines, the shorter one about one-half as long as the other, at apex bent at a right angle into a long spinous point.

HABITAT: Mexico (Chiapas). *Holotype*, ♂, San Antonio Nexapa, November 20, 1932 (Parra); through Dampf, M. F. 2220. *Paratopotypes*, ♂♂.

This fly is most similar to the Costa Rican *Gonomyia* (*Gonomyia*) *bifurcifer* Alexander, which has the hypopygium of the same general structure but differs in certain important details, particularly the outer dististyle and the phallosome. This latter structure has the two subequal arms very long and slender, quite different from the present fly.

Gonomyia (Gonomyia) juarezi sp. n.

Allied to *aequalis;* general coloration of mesonotum grayish brown, variegated with yellow, the latter including the broad anterior central portion of the scutum and all but the base of the scutellum; halteres elongate, stem pale, knob darkened; male hypopygium with the outer lobe of basistyle unusually short and stout, dark-colored, pointed at apex; outer dististyle a small pale setuliferous cushion; inner dististyle truncated at apex, bearing a strongly curved blackened spine; phallosome complex, bearing three spines or spine-tipped arms.

Male.—Length about 5.5 mm.; wing, 6 mm.

Rostrum obscure brownish yellow; palpi black. Antennae with basal segments brownish black, outer segments broken. Head gray; eyes large.

Pronotum and pretergites yellow. Mesonotum with disk of praescutum almost covered by a dark grayish brown shield, the lateral borders yellow; scutal lobes chiefly grayish brown, extended posteriorly onto the base of the scutellum, leaving conspicuous yellow areas on the anterior median region of the scutum, posterior portions of scutal lobes and the broad scutellum; mediotergite chiefly darkened, the lateral border and the pleurotergite paler, pruinose. Pleura reddish brown, very vaguely patterned. Halteres elongate, stem pale, knob darkened. Legs with the coxae reddish yellow; trochanters obscure yellow; remainder of legs dark brown. Wings with a weak grayish tinge, the prearcular and costal fields somewhat more whitened; stigma very pale brown; veins brown, somewhat lighter in the paler areas. Venation: Sc_1 ending immediately before the origin of *Rs*, Sc_2 near its tip; *Rs* and R_{2+3+4} subequal in length; cell *1st* M_2 rectangular, shorter than the distal section of M_3; *m-cu* a short distance beyond the fork of *M*.

Abdominal tergites dark brown; sternites more yellowed; hypopygium brownish yellow, the dististyles darker. Male hypopygium with the outer lobe of basistyle relatively short and very stout, only

about two-thirds as long as the remainder of the basistyle and approximately equal to the total length of the dististyle; lobe dark-colored, pointed at apex, with setae on outer face. Outer dististyle a small oval setuliferous cushion. Inner dististyle larger, truncated at apex and here bearing the usual two fasciculate setae; on outer margin, close to apex, with a powerful, very strongly curved black spine. Phallosome complex, bearing various spinous points, including a major recurved blackened rod a short distance back from tip, this terminating in a long acute spinous point; more basad, a somewhat similar but paler blade, its apical point directed caudad; margin of phallosome near base with a still smaller blackened point.

HABITAT: Mexico (Oaxaca). *Holotype*, ♂, Yotao, Sierra de Juarez, at light, 6–8 P. M., September 15, 1935 (Fr. Reyes); Dampf M. F. 6241.

This fly is allied to various other species in Mexico and Guatemala, including *Gonomyia* (*Gonomyia*) *aequalis* Alexander, *G.* (*G.*) *chiapasensis* Alexander, and *G.* (*G.*) *guerreroensis* Alexander, differing from all in the structure of the male hypopygium, particularly the outer lobe of the basistyle, inner dististyle and phallosome.

Gonomyia (Lipophleps) impedita sp. n.

Belongs to the *manca* group; size relatively large (wing, male, over 4 mm.); general coloration of mesonotum dark brownish gray, the scutellum chiefly light yellow; thoracic pleura grayish brown, with a yellowish white longitudinal stripe; legs brownish black; wings with a brownish tinge, the oval stigma a little darker than the ground; Sc_1 ending before origin of *Rs* a distance about equal to one-half the length of the latter; male hypopygium with the outer angle of the basistyle produced into a strong blade that terminates in a blackened spine; dististyle elongate, subequal in length and shape to the blade of the basistyle; phallosome terminating in two long slender unequal spines.

Male.—Length about 4.5 mm.; wing, 4.3 mm.

Rostrum and palpi black. Antennae black throughout. Head light gray behind, the center of vertex with a more brownish spot.

Pronotum and pretergites clear light yellow. Mesonotal praescutum and scutum dark brown, heavily gray pruinose; scutellum behind broadly light yellow, narrowly darkened medially at base, parascutella dark; mediotergite dark brown, heavily pruinose; pleurotergite chiefly yellow, sparsely pruinose. Pleura grayish brown, with a conspicuous yellowish white longitudinal stripe across the central pleurites, beginning behind the fore coxae and involving the dorsal sternopleurite, ventral pteropleurite and metapleura. Halteres with stem obscure yellow, knob infuscated. Legs with the coxae and trochanters yellow; remainder of legs dark brown to brownish black. Wings with a brownish tinge, the prearcular and costal fields more whitened; stigma oval, very pale brown, only a trifle darker than the ground; veins brown, those in the prearcular field paler. Venation: Sc_1 ending before the origin of *Rs* a distance about equal to one-half the length of the latter; *m-cu* immediately before the fork of *M*.

Abdominal tergites dark brown, sternites paler; hypopygium yellow. Male hypopygium with the basistyle small, oval in outline, the outer portion produced into a powerful sclerotized blade that is longer than

the style itself, the basal two-thirds glabrous, the distal portion narrowed to an acute blackened spine, the margin back from the tip more or less concave and provided with microscopic setulae, these latter continued down the margin of the blade to opposite the point of insertion of the dististyle. Dististyle elongate, nearly as long as the blade of the basistyle and having nearly the same general outline, narrowed to the apex which bears a single seta, with other scattered setae on the distal four-fifths; fasciculate bristles on margin of outer third, their length exceeding the width of the style opposite their point of origin. Phallosome terminating in two long spinous points, the shorter one almost straight, very acute, its surface with scattered microscopic setulae; longer spine from a dilated base, gently curved, very gradually narrowed to the acute tip, the surface glabrous.

HABITAT: Mexico (Oaxaca). *Holotype*, ♂, Cacalotepec, Sierra de Juarez, November 14, 1935 (Fr. Reyes); Dampf M. F. 6239.

In the *manca* group of the subgenus, among those forms having the dististyle of the male hypopygium subterminal in position, numerous species have the outer projecting lobe of the basistyle fleshy and setiferous while fewer species have this lobe more or less modified into a sclerotized spine or blade. Such species in the Neotropical fauna include *Gonomyia* (*Lipophleps*) *bispinosa* Alexander, *G.* (*L.*) *borburatana* Alexander, *G.* (*L.*) *diacanthophora* Alexander, *G.* (*L.*) *macintyrei* Alexander, *G.* (*L.*) *misera* Alexander, *G.* (*L.*) *orthomera* Alexander, *G.* (*L.*) *orthomeroides* Alexander, *G.* (*L.*) *reyesi* sp. n., and *G.* (*L.*) *senaria* Alexander. Among these species, the present fly is most similar to *macintyrei* (Ecuador) and *senaria* (Peru), differing conspicuously from both in the structure of the basistyle and, especially, of the phallosome.

Gonomyia (Lipophleps) reyesi sp. n.

Belongs to the *manca* group; size small (wing, male, under 3.5 mm.); general coloration of thorax pale to medium brown, without pattern; legs pale brown, the outer tarsal segments darker; wings with a brownish tinge; *Sc* short; male hypopygium with the outer lobe of basistyle a slender black rod, terminating in a short acute spine, back from the tip with numerous delicate setulae; dististyle relatively long, the two fasciculate setae unequal in size, terminal in position; phallosome consisting of a very long and powerful median rod, strongly sinuous, its tip prolonged into a straight blackened spine.

Male.—Length about 3 mm.; wing, 3.2–3.3 mm.

Rostrum and palpi black. Antennae black, the verticils of male very long. Head with the anterior vertex and broad orbits obscure yellow, the central region of vertex pale brown.

Pronotum and pretergites yellow. Mesonotum almost uniformly pale to medium brown, the posterior border of scutellum narrowly obscure yellow. Pleura medium brown, with no clearly indicated pattern. Halteres weakly infuscated. Legs with the coxae and trochanters pale yellow; remainder of legs very pale brown, the outer tarsal segments darker. Wings with a brownish tinge, the prearcular and costal fields pale yellow; stigma very pale brown, barely indicated against the ground; veins brown, those at the wing base a little paler. Venation: Sc_1 ending before origin of *Rs* a distance about equal to two-

thirds to three-fourths the length of the latter; *m-cu* shortly before the fork of *M*.

Abdomen brown, the hypopygium yellow. Male hypopygium with the outer lobe of basistyle a slender black rod, slightly sinuous at base, the outer two-thirds straight, terminating in a short acute spine; before the spine and for a distance back from tip with abundant microscopic setulae that become more sparse toward midlength of the lobe. Dististyle about three-fifths as long as the spine of basistyle and more than twice as broad; fasciculate setae unequal in size, one about twice as stout as the other, both placed at apex of style. Phallosome entirely glabrous, consisting essentially of a very long and powerful median rod, flattened and strongly sinuous, the tip produced into a long straight blackened spine; at base of the major rod with a small oval pale blade.

HABITAT: Mexico (Oaxaca). *Holotype*, ♂, San Cristobal, altitude 150 meters, December 13, 1937 (A. M. Dampf); M. F. 6362. *Paratopotypes*, 4 ♂♂, December 13–19, 1937; M. F. 6362, 6435.

I am pleased to name this distinct fly for Mr. Francisco Reyes, one of Doctor Dampf's most efficient inspectors. Like the preceding species, the present fly belongs to the aggregation of forms that have the dististyle of the male hypopygium subterminal in position and with the outer lobe of the basistyle prolonged into a spinous rod or blade. It is entirely distinct from all those forms listed under the preceding species, differing particularly in the lobe of the basistyle and the powerful central rod of the phallosome. As in the case in various other species of *Lipophleps*, the suture of the dististyle is poorly developed, indicating a partial fusion with the basistyle.

Gnophomyia Osten Sacken

Gnophomyia (Gnophomyia) monophaea sp. n.

General coloration dull black, the anterior pretergites conspicuously yellow; head pruinose in front, with a small, simple vertical tubercle; knobs of halteres brownish black; wings with a weak brownish tinge, variegated by a conspicuous darker brown cloud over the anterior cord; *Rs* short and straight, subequal to R_{2+3+4}; branches of *Rs* long, extending generally parallel to one another; cell *1st* M_2 elongate-rectangular, with *m-cu* at midlength.

Female.—Length about 7.5 mm.; wing, 7.3 mm.; antenna about 2.9 mm.

Rostrum and palpi brownish black. Antennae with scape and pedicel dark brown, flagellum brownish black; scape relatively short, subequal to the first flagellar segment; flagellar segments elongate, subcylindrical or slightly swollen before midlength; longest verticils exceeding the segments in length; terminal segment about four-fifths the length of the penultimate. Head dull black, the front pruinose; a small simple vertical tubercle; anterior vertex broad, about three times the diameter of the scape.

Pronotum darkened above; pretergites conspicuously light yellow. Mesonotal praescutum dull black medially, the humeral region more reddened; posterior sclerites of notum dull black, the posterior border of the praescutum more reddened. Pleura with a broad black dorsal

stripe extending from the cervical region across the dorsal propleura to the pteropleurite, the latter paler; beneath the dorsal stripe with a conspicuous brownish yellow longitudinal stripe extending from behind the fore coxae to the meron and metapleura, the surface sparsely pruinose; ventral sternopleurite black, pruinose. Halteres with stem obscure yellow, knob brownish black. Legs with coxae and trochanters yellow; femora brown; tibiae and tarsi passing into black. Wings with a weak brownish tinge, variegated by a conspicuous darker brown cloud over the anterior cord, involving the bases of the outer radial cells; stigma long and narrow, brown, not connected with the discal darkening; veins brownish black. Venation: Sc long, Sc_1 ending just beyond the fork of R_{2+3+4}, Sc_2 some distance from the tip of Sc_1, the latter being about four-fifths Rs; Rs short and straight, subequal to or a trifle longer than R_{2+3+4}; cord at near midlength of wing, the branches of Rs long, extending generally parallel to one another throughout their lengths; cell *1st M* elongate rectangular, only slightly wider at outer end, subequal in length to vein M_4 beyond it; *m-cu* at midlength of cell *1st* M_2.

Abdomen dark brown, the caudal borders of the intermediate tergites narrowly paler; genital segment brownish black; cerci long and conspicuous, compressed-flattened; hypovalvae very short.

HABITAT: Mexico (Chiapas). *Holotype*, ♀, Nueva America, February 22, 1931; no Dampf M. F. number.

This fly is readily distinguished from all other regional species by the pattern and venation of the wings, especially the short straight Rs, unusually long radial branches, and long-rectangular cell *1st* M_2, with *m-cu* at midlength. It appears to be closest to various species centering around *Gnophomyia* (*Gnophomyia*) *maestitia* Alexander but is very distinct.

Erioptera Meigen

Erioptera (Empedomorpha) apacheana sp. n.

General coloration yellow, the notum variegated with brownish gray, including three nearly confluent praescutal stripes; pleura yellow, striped longitudinally with brownish gray; halteres yellow; legs yellow, the tips of the more proximal segments tipped with darker; wings pale yellow, stigmal region in male greatly dilated and hairy; male hypopygium with the outer dististyle simple, its tip acute, phallosome with four apophyses, the lateral pair shorter, slightly bidentate at tips; inner apophyses appearing as slender yellow rods that bear conspicuous black lateral spines.

Male.—Length about 4.5–6 mm.; wing, 4.8–8 mm.

Female.—Length about 4.5 mm.; wing, 4.5 mm.

Rostrum brownish yellow; palpi pale brown. Antennae brown, in cases the flagellum paler; flagellar segments long-oval, with elongate verticils. Head pale yellow.

Pronotum yellow medially, restrictedly patterned with brown. Mesonotal praescutum with the ground light yellow, almost covered by three broad brownish gray stripes that tend to become entirely confluent; in cases, the central stripe with a further delicate median

brown vitta; scutal lobes darkened; central portion of scutum yellow, with a further weak median darkening; scutellum pale brown; postnotum pale brownish gray. Pleura yellow, striped longitudinally with brownish gray. Halteres yellow. Legs long and hairy, as in the subgenus; coxae yellow, the fore pair more darkened; trochanters obscure yellow; femora, tibiae and proximal two tarsal segments yellow, the tips narrowly infuscated; outer tarsal segments darkened; claws simple. Wings with a pale yellowish or whitish tinge, the veins brown, paler in the prearcular and costal fields. Stigmal region in male greatly expanded and dilated, provided with abundant trichia; in female, this field less dilated but with the venation approximately the same. Venation: *Rs* long and straight, with R_2, R_{3+4} and R_5 all arising from its end; R_2 long and oblique, exceeding R_{1+2}; cell R_3 shallow, about one-half its petiole; cell *1st* M_2 closed; *m-cu* at the fork of *M;* vein *2nd A* straight or virtually so.

Abdomen dark brown, the hypopygium a little paler. Male hypopygium with the outer dististyle a simple flattened blade, dilated just before the acutely pointed apex, without armature, as has *empedoides.* Inner dististyle subequal in length, a little wider on distal two-thirds, the tip obtuse; at and near apex with a few setigerous punctures. Phallosome consisting of four slender blades, the lateral pair shorter, blackened at tips which are weakly bifid; inner apophyses appearing as longer yellow spinous points, each bearing an acute blackened lateral spine.

HABITAT: Mexico (Nuevo Leon). *Holotype,* ♂, Granja Rodriguez, altitude 195 meters, June 6, 1931 (A. M. Dampf); M. F. 2046. *Allotopotype,* ♀, pinned with type. *Paratopotypes,* 8 ♂♂, June 5–6, 1931; M. F. 2029, 2046.

The only other described species of *Empedomorpha* Alexander is the subgenotype, *empedoides* (Alexander) of the central and southwestern United States. This latter has the same peculiar sexual dimorphism and shows the great range in size in the male sex that is found in the present fly. The two species differ evidently in the structure of the male hypopygium, especially the dististyles.

Erioptera (Mesocyphona) leonensis sp. n.

Allied to *modica;* general coloration of mesonotum dark gray, the praescutum with two brown stripes; legs light brown or yellowish brown, unpatterned; wings with a pale brownish tinge, unpatterned; male hypopygium with the dististyle three-branched on two principal stems, the outer branch a long powerful black spine that is weakly forked near apex; lower stem dividing into two branches at near mid-length, the outer branch with a long comb of darkened teeth along outer margin; gonapophysis of either side single, appearing as a long curved black glabrous spine.

Male.—Length about 2.5 mm.; wing, 3 mm.

Female.—Length about 3 mm.; wing, 3.5 mm.

Rostrum and palpi brownish black. Antennae with scape and pedicel brownish black; flagellum much paler, brownish yellow. Head above dark brown, more yellowed in front.

Pronotum dark brownish gray, the lateral borders narrowly yellow;

pronotal scutellum and the pretergite less evidently brightened. Mesonotum dark gray, the praescutum with two brown stripes that converge behind, leaving a broad median ground area; scutellum yellowish testaceous, postnotum dark brown, gray pruinose. Pleura dark brownish gray, with a poorly delimited, clearer gray longitudinal stripe; dorsopleural region dusky. Halteres with stem yellow, knob weakly darkened. Legs with the fore coxae brownish black, remaining coxae obscure yellow; trochanters yellow; remainder of legs light brown or yellowish brown, unpatterned. Wings with a pale brownish tinge, the prearcular and costal regions a little more yellowed; stigmal area very vaguely and diffusely darker; veins pale brown; macrotrichia darker. Venation: Cell M_2 open by the atrophy of the basal section of M_3; vein *2nd A* with the distal third gently sinuous.

Abdomen dark brown, the sternites a trifle paler; hypopygium dark brown to brownish black. Male hypopygium with the dististyle three-branched, including two main stems; outer stem a long powerful black spine, gently sinuous, gradually narrowed to the acute spinous tip, before the latter with a smaller lateral point; inner stem of about the same diameter, at near midlength forking into two branches, a long-triangular outer blade that narrows to the subacute point, the outer margin with a long comb of darkened teeth; inner arm a little shorter, appearing as a slender rod, the apex obtuse. Gonapophyses single on either side, each appearing as a long, gently curved, black rod that narrows gradually to the acute tip, the surface glabrous.

HABITAT: Mexico (Nuevo Leon). *Holotype*, ♂, Montemorelos, June 3, 1931 (A. M. Dampf); M. F. 2023. *Allotopotype*, ♀. *Paratopotypes*, several ♂ ♀.

The most similar described species is *Erioptera* (*Mesocyphona*) *modica* Alexander, of southern Mexico, which differs especially in the structure of the male hypopygium, particularly the peculiarly modified outer stem of the dististyle.

Cryptolabis Osten Sacken

Cryptolabis (Cryptolabis) luteola sp. n.

General coloration of entire body and appendages pale yellow; macrotrichia of wings relatively numerous in all cells beyond the cord; *Rs* relatively long and sinuous; *m-cu* shortly before the fork of M_{3+4}, cell M_3 deep; male hypopygium with the slender dististyle terminal in position, arcuated, the tip produced into an acute spine; aedeagus stout, its distal portion weakly convoluted.

Male.—Length about 4 mm.; wing, 3.9 mm.

Rostrum and palpi light yellow. Antennae with the scape and pedicel yellow; flagellum broken. Head uniformly pale yellow.

Thorax yellow, the notum a little more obscure than the pleura. Halteres yellow. Legs yellow. Wings yellow, the veins a little darker but well-delimited by conspicuous black macrotrichia. Macrotrichia in all cells beyond cord, chiefly occurring as linear series in the centers of the cells. Venation: *Rs* relatively long and sinuous; R_{2+3+4} suberect; R_2 oblique; outer radial branches gently upcurved at margin; *m-cu* shortly before fork of M_{3+4}; cell M_3 deep.

Abdomen obscure yellow. Male hypopygium with the dististyle terminal, arcuated and unusually slender, especially the darkened apical spine; outer surface of style immediately back from apex with two microscopic points; still further back from apex with two conspicuous erect setae. Aedeagus stout, particularly at base, the outer portion weakly convoluted but not bent back upon itself.

HABITAT: Mexico (Chiapas). *Holotype*, ♂, Huehuetan, altitude 40 meters, November 9, 1942 (A. M. Dampf); M. F. 2743.

Cryptolabis (*Cryptolabis*) *luteola* is readily told from related species by the uniformly pale yellow coloration of the body, and by the structure of the male hypopygium, especially the dististyle. The pale color is not due to a teneral condition since all structures are evidently fully colored.

Cryptolabis (Cryptolabis) parrai sp. n.

General coloration of thorax yellow, variegated with dark brown, including three praescutal stripes; head pale yellow; halteres with stem dusky, knob obscure yellow; wings whitish subhyaline, the outer cells with macrotrichia; *Rs* short and nearly straight, oblique; cell R_1 triangular in outline; *m-cu* about one-third its length before the fork of M_{3+4}; male hypopygium with the dististyle a paddle-like arcuated blade, before its apex with five or six powerful darkened spines; aedeagus straight, unusually slender on more than the outer half.

Male.—Length about 3.5 mm.; wing, 3.9 mm.

Rostrum brownish yellow; palpi brownish black. Antennae with scape black; remainder of organ broken. Head pale yellow.

Pronotum above testaceous yellow, darker on sides. Mesonotum obscure testaceous yellow, variegated with dark brown, including three praescutal stripes and the scutal lobes; posterior sclerites of notum somewhat paler brown. Pleura dark brown, restrictedly patterned with paler, including the dorsopleural membrane and the dorsal portion of the sternopleurite. Halteres with stem dusky, yellow basally, knob obscure yellow. Legs with the coxae and trochanters yellow; femora and tibiae brownish yellow, the tips narrowly more darkened; tarsi broken. Wings whitish subhyaline; veins brown. Macrotrichia of outer wing cells numerous, occurring in cells R_2 to *Cu*, inclusive. Venation: *Rs* short and nearly straight, oblique; cell R_1 triangular in outline; *m-cu* about one-third its length before the fork of M_{3+4}.

Abdomen brown, the hypopygium a little more brownish yellow. Male hypopygium with the dististyle terminal in position, unusually conspicuous, appearing as a flattened paddle-shaped blade, arcuated, the tip obtuse; before apex with five or six powerful darkened spinous points that are directed outwardly. Aedeagus straight, uncoiled, stout on basal fourth, thence narrowed gradually to the tip, for most of the length unusually slender.

HABITAT: Mexico (Chiapas). *Holotype*, ♂, San Antonio Nexapa, November 20, 1932 (Parra); M. F. 2220.

I take great pleasure in naming this very distinct fly for the collector, Inspector Josè Parra. It differs from other generally similar regional members of the subgenus, as *Cryptolabis* (*Cryptolabis*) *luteiceps* Alexander, in the structure of the male hypopygium, particularly the spinous points on the dististyle and the conformation of the aedeagus.

Molophilus Curtis

Molophilus (Molophilus) pustulatus sp. n.

Belongs to the *plagiatus* group; size relatively large (wing, male, 6 mm.); general coloration brownish black; antennae short; knobs of halteres very weakly darkened; wings with a brownish suffusion, darker in the stigmal area; male hypopygium with the basal dististyle an elongate rod, narrowed gradually to the acute spinous point, the apical fifth bent at virtually a right angle to the remainder; surface of style with abundant microscopic spinulae over most of the length.

Male.—Length about 5.5 mm.; wing, 6 mm.

Rostrum light brown; palpi black. Antennae dark brown, broken beyond the fourth segment; basal flagellar segments short-cylindrical, the entire organ evidently short. Head light gray; anterior vertex and orbits darker gray; center of vertex dark brown.

Pronotum above obscure yellow, darker on sides; pretergites clear light yellow. Mesonotal praescutum almost entirely and uniformly dark brown, the interspaces more reddened; humeral triangle yellow; scutum chiefly dark brown, the lobes more reddened behind; posterior sclerites of notum dark brown. Pleura almost uniformly dark reddish brown, including the dorsopleural membrane. Halteres with stem yellow, knob very weakly darkened. Legs with coxae clear light yellow; trochanters yellow; femora and tibiae obscure yellow, the tips narrowly darkened; proximal tarsal segments obscure brownish yellow, the outer ones darker. Wings with a relatively strong brownish suffusion, the stigmal region and a seam along *Cu* a little more darkened; prearcular field light yellow; veins brown, brighter in the prearcular area. Venation: R_2 lying just beyond the level of *r-m;* petiole of cell M_3 approximately twice the gently sinuous *m-cu;* vein *2nd A* long, ending about opposite midlength of the petiole of cell M_3.

Abdomen, including hypopygium, brownish black. Male hypopygium with the beak of the basistyle slender. Outer dististyle a gently curved rod, the apical arms very unequal in size and shape, the outer long and slender, the shorter lower arm more sheathing. Basal dististyle an elongate rod, straight for most of the length, the apical fifth bent at virtually a right angle to the remainder; basal fourth of style more swollen, provided both above and beneath with small spinous points; the organ thence very gradually narrowed to the acute tip, the surface with the small spinous points virtually to the apex. Phallosomic plate with the outer portion suboval, rounded, the margin smooth. Aedeagus elongate, slender.

HABITAT: Mexico (Chiapas). *Holotype*, ♂, Nueva America, February 22, 1931; no Dampf M. F. number.

This very distinct species requires little comparison with other regional forms. In its general appearance it somewhat resembles various species, such as *Molophilus* (*Molophilus*) *falx* Alexander, with elongate antennae in the male sex but such similarity is entirely superficial. The structure of the male hypopygium, particularly the basal dististyle, of the present fly is entirely distinctive.

IDENTIFICATION OF CULEX MALES UNDER LOW MAGNIFICATION

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The male hypopygia of most mosquito genera afford excellent means of specific identification, with the result that in this country little attention has been given to other methods of male mosquito identification. To study the hypopygium it usually is necessary to remove the tip of the abdomen, clear it with caustic potash and mount on a slide for study with the compound microscope. When large numbers of specimens are received daily for determination the time required for preparation of the hypopygium becomes excessive, therefore the writer was faced with the alternatives of finding more expedient means of determining the *Culex* males, or not studying them at all.

The purpose of this article is to set forth characters whereby males of the ten species of *Culex* which occur in Georgia can be distinguished by the low powers of the binocular microscope. The most useful structures for this purpose are the palpi. The palpi are paired, lie just above the proboscis, and in all male *Culex* studied they exceed the length of the proboscis by at least the length of their apical segment and have the apical two segments turned upwards. These two segments are subequal in diameter to the preceding segments, are usually scaled on the dorsal and ventral surfaces, and, together with the apical part of the antepenultimate segment, are fringed laterally with long hairs. By the long, upturned palpi male *Culex* can be distinguished from all other North American mosquitoes, but the genus is further recognized by the nature of the hypopygium. In gross structure the latter consists of two lobes (side pieces) each bearing a terminal process (clasper). In *Culex* the claspers are parallel, and together with the side pieces, resemble somewhat the flexed human index and middle finger; in the other genera the claspers are opposed to each other, like the index finger and the thumb. Except for *Culex tarsalis*, which is very rare in Georgia, the legs are not ringed with white scales and the species are medium sized and brownish, or smaller and darker.

Representatives of all three North American subgenera of *Culex* occur in Georgia. In the male sex these subgenera and their Georgian species may be characterized as follows:

Culex (*Neoculex*). Abdominal tergites pale-scaled apically; wing scales narrow; apical two segments of palpi ventrally with sparse, very narrow (five to six times longer than wide) scales, which are not visible at low magnification. Our single species, *Culex apicalis* Adams, is easily recognized by the pale scales on the apices of the abdominal tergites. It is a rather small species, with thorax brown, paler than the abdominal

[1]Contribution of the Georgia State Board of Health.

tergites. The venter of the abdomen is entirely clothed with silvery scales.

Culex (*Melanoconion*). Wing scales moderately broadened; abdominal tergites dark scaled, with a basal white spot laterally, or with narrow, pale basal bands, thoracic vestiture usually dark brown. Small, dark species with wings appearing dusky because of the broadened scales. The vestiture of the palpi and abdominal sternites is variable, according to the species.

Culex (*Melanoconion*) *erraticus* Dyar & Knab. Apical two segments of palpi entirely clothed below with dark scales having a coppery luster, lateral fringe of hairs normal; venter of abdomen banded, each sternite with pale scales basally and dark scales apically. This is the largest and most common species of the subgenus, but is variable in size and vestiture. The thorax is often clad with golden scales, and the abdominal tergites are not infrequently with narrow basal bands of pale scales.

Culex (*Melanoconion*) *peccator* Dyar & Knab. Apical two segments of palpi entirely clothed below with dark scales having a coppery luster, lateral fringe greatly reduced, consisting of about twelve short bristles; venter of abdomen (as in the female) entirely clad with white scales. This species is widespread but rather rare. It may be immediately recognized by the reduction of the lateral apical fringes of the palpi, and by the enlarged tip of the abdomen. The ventral pale scaling distinguishes both sexes from the other two species of *Melanoconion;* this character has not been previously recognized.

Culex (*Melanoconion*) *pilosus* Dyar & Knab. Apical two segments of the palpi each with a small basal patch of whitish scales ventrally, lateral fringe normal; venter of abdomen banded, as in *Culex erraticus.* This is our smallest species of *Culex*, and may be recognized by the small patch of sordid white scales at the base of each of the apical two palpal segments.

Culex (*Culex*). Medium-sized, brownish species, with narrow wing scales and palpi spotted or streaked with (usually) white scales ventrally on the last two segments; abdomen dorsally with a white or yellow band of scales at the base of each segment; abdominal sternites pale-scaled, sometimes with darker median spots.

Culex (*Culex*) *nigripalpus* Theobald. Palpi unusually long, very heavily fringed laterally and with patches of sordid white scales ventrally. Thoracic vestiture black; abdominal tergites with (usually) inconspicuous bands of white scales. This species is easily separated from the other *Culex* (*Culex*) studied by the above-mentioned palpal characters and the black vestiture of the thorax.

Culex (*Culex*) *quinquefasciatus* Say (*Culex fatigans* Wied., of extra-North American authors). Penultimate segment of palpi with a stripe of white scales below, extending from the base of the segment to the apical third or quarter of its length; apical segment with a patch of white scales at its base. Thorax with brownish vestiture having some luster. Abdomen dorsally with broad bands of white scales at the base of each segment, these bands continued along the sides of each segment; venter of abdomen with white or whitish scales, sometimes with a median darker spot on each segment. *Culex quinquefasciatus* is the common house mosquito of the South, and tropics of the world. The males are

easily distinguished from all species except *pipiens* by the stripe of white scales on the ventral side of the antepenultimate palpal segment.

Culex (*Culex*) *pipiens* Linn. is very closely related to *quinquefasciatus*. The writer has not observed how its male differs from that species if it differs at all in characters other than the male hypopygium. *Culex pipiens* is the house mosquito of the north temperate zone. Larvae and females have been recognized from Atlanta and Rome, Georgia.

Culex (*Culex*) *salinarius* Coq., *tarsalis* Coq. and *restuans* Theobald all agree in the nature of the male palpi, which have three spots of white scales on the ventral sides of the apical two segments. Two of these spots are situated basally on each segment; the third is situated on the penultimate segment, beyond the middle of its length. These three species are easily separated from each other by the other characters given in the key which follows. *Tarsalis* is extremely rare in Georgia; *restuans* is quite common during the winter months; *salinarius* occurs throughout the season and is widely distributed, though not abundant.

KEY TO THE MALE CULEX OF GEORGIA

1. Penultimate segment of palpi with conspicuous ventral spots or stripes of white scales....................2
   Penultimate segment of palpi with spots inconspicuous, sordid white or absent....................5
2. Penultimate segment of palpi with a ventral stripe extending for more than half its length....................**quinquefasciatus** and **pipiens**
   Penultimate segment of palpi with two ventral spots, one basal, the other beyond its middle....................3
3. Tarsi banded with white; thorax variegated with bright brown and white vestiture....................**tarsalis**
   Tarsi unicolorous, brown; thorax unicolorous brown or faintly marked with white....................4
4. Abdominal dorsal bands of brownish-yellow scales; thorax with uniform dark brown vestiture....................**salinarius**
   Abdominal dorsal bands of white scales; thorax with faint streaks of whitish scales at base and often with two median dots of whitish scales......**restuans**
5. Apical two segments of palpi ventrally with small basal spots of sordid white or brown scales....................6
   Apical two segments of palpi without patches of scales ventrally....................7
6. Palpi heavily fringed laterally, long, the tip of proboscis attaining the basal half of the penultimate segment; penultimate segment with a small patch of brownish scales beyond the middle of its length; wing scales narrow; venter of abdomen not banded....................**nigripalpus**
   Palpi of normal length, with lateral fringe normal, and penultimate segment without scale patch beyond middle; a smaller, dark species with wing scales broadened and sternites with white basal bands of scales....................**pilosus**
7. Apical two segments of palpi apparently not scaled below; abdomen dorsally with a narrow band of white scales on the apical margin of each segment, **apicalis**
   Apical two segment of palpi with continuous dark scaling with bronzy luster ventrally; abdominal dorsal white scales basal, if present....................8
8. Lateral bristles of apical palpal segments numerous as is the rule; venter of abdomen banded with white; hypopygium not greatly enlarged....**erraticus**
   Lateral bristles of apical palpal segments very sparse; venter of abdomen uniformly white-scaled; tip of the abdomen appears swollen, due to the large hypopygium....................**peccator**

A NOTE ON THE CULTURING OF CHIGGERS (TROMBICULIDAE)[1]

CAPT. ROY MELVIN, Sn. C., A. U. S.

During the course of an investigation on the toxicity and repellency of various organic compounds to arthropods affecting man, studies were made on methods of propagating chiggers in the laboratory for test and taxonomic purposes. A brief discussion of the technique found most successful follows. A satisfactory culture medium for most of the species of chiggers studied consisted of soil and chicken manure from the floor of a chicken house. The soil was rendered free of animal life by heating it in a dry oven. There was some clay in the soil, and when wet samples were heated there was a tendency for many small pellets to form which allowed interspaces in the cultures, thus permitting the mites to adjust themselves more readily to the proper condition of moisture. It was later found that the medium could be duplicated by mixing one part chicken manure with five parts of soil from other sources.

The rearing chamber consisted of 50 cubic centimeter wide mouth bottles about one-half full of the treated soil. Moisture was added at irregular intervals depending on the rate of evaporation, but at all times the soil in the bottom of the bottle was damp. The bottles were placed in the centers of discs of dimethyl phthalate treated blotter paper which prevented contamination of the cultures by other mites and at the same time prevented the escape of the test mites.

In starting cultures with adult chiggers, each adult was placed in a separate bottle and allowed to remain therein for 8 to 14 days before being removed and preserved for study. If live larvae were desired the bottles were plugged with cotton surrounded with silk cloth. If association of larvae with their respective adults was all that was desired, the bottles were left open allowing larvae to migrate out and be killed by the dimethyl phthalate on the blotter paper.

When it was desired to complete the life cycle the silk lined stopper was removed and by means of a camel's hair brush, newly hatched larvae were transferred to the bare axillary skin of one to three weeks old baby chicks. A large percentage of the larvae established when thus transferred. The chicks were kept in glass battery jars for five to six days by which time the larvae had engorged and detached. Engorged larvae were transferred to culture bottles. White rice only was fed the chicks as unconsumed rice did not interfere with the finding of larvae. Feces of chicks of this age were rather dry and entrapped only a small per cent of the larvae.

[1]The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the Gorgas Memorial Laboratory, Panama City, R. de P.

The author is greatly indebted to Dr. Herbert C. Clark, Director of the Gorgas Memorial Laboratory, for supervision and the assistance in making these studies possible.

Nymphs appeared in the culture bottles in 9 to 18 days after the introduction of the engorged larvae. Small amounts of water, one to two cubic centimeters were added to the bottles about every week and no other care was given the cultures until some two weeks after adults appeared. Experience had shown that few or no eggs are laid if the adults were kept at laboratory temperatures. The daily maximum laboratory temperature seldom reached 30° C., and the daily minimum temperature was often 20° C. Heating the cultures to about 35° C. for two to three days was conducive to good egg production, but long exposure to this temperature was often fatal.

The second generation of larvae appeared in about 19 days, and the cycle was repeated using mass cultures.

Engorged larvae of unknown species, generally mixtures of several species, from host animals were cultured in the same way as those obtained from chicks, except that the resulting adults were removed and placed into individual culture bottles before subjection to the elevated temperature required for oviposition.

Eutrombicula hominis Ewing and a new species of ***Eutrombicula*** to be described in a subsequent publication were bred through two or more generations. Data on the length of the various stages are very incomplete, but they indicate that there is a close similarity in the life cycle of the two species studied. The eggs are laid in clusters which remind one of dewberries. Contrary to reports on other species of Trombiculidae, these two species lay a large number of eggs at one time. This was also the case with several other species in which a partial life cycle was obtained. One female of the new species of ***Eutrombicula*** mentioned above laid a cluster of 56 eggs over night. And in another case 87 larvae were bred from a single female that was confined in treated soil for eight days. The minimum time from the introduction of the adult to the hatching of the larvae was about 19 days, thus the incubation period was slightly less. Larvae generally completed engorgement on the chicks in three to six days and transformed into nymphs in another six to ten days. No accurate data on the length of the nymphal stage are available, but in one instance it was known to be less than 42 days. The time required to complete the life cycle was about three months.

THE ICHNEUMON-FLIES OF THE GENUS CRYPTANURA BRULLE, MAINLY TROPICAL AMERICAN, by R. A. CUSHMAN. Proceedings of the United States National Museum, Volume 96, No. 3193, pages 139–176, 1945.

This article does not attempt a survey of all species belonging to the genus, but rather a critical evaluation of the generic characters and a revision of the past association of species with it. Several species are removed from *Cryptanura* to *Glodianus*, *Photocryptus*, *Trapezonalis*, and a new genus *Cremnocryptus*. A key to thirty-three species is included, of which most are described as new and several are placed in the genus for the first time. A second key to all species of *Cryptanura*, based partly on descriptions, is included.—A. W. L.

ANALYSIS OF CONCENTRATION-SURVIVAL TIME CURVES OF ARSENITE-INJECTED ROACHES HAVING DIFFERENT RESISTANCES

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In a previous paper (1) the authors presented an analysis of concentration-survival time curves for the American and oriental cockroaches, ***Periplaneta americana*** (L.) and ***Blatta orientalis*** L., injected with sodium metarsenite and then kept at approximately 80° C. and 65–80 percent relative humidity without food or water. These curves exhibited regions of inflection and critical zones. Certain characteristics of the curves, including the inflections, were explained on the basis of a hypothesis which took into consideration the electrolytic dissociation of the poison in the blood of the injected insects, as well as other physiological processes such as detoxification, excretion, the latent period, and the fundamental lethal reaction, that would be expected to take place. Further analysis of the data of these experiments, particularly of the five replicate experiments 5 A–E, with ***P. americana***, have yielded results of interest from the standpoint of the question, Why can some individual insects of a species survive a given dosage of insecticide for a longer time than other individuals? In this paper the results of the further analysis are reported and discussed.

DATA AND CALCULATIONS

The data consist of the shortest and the longest individual survival times of roaches that were injected with the various concentrations of sodium metarsenite. The survival times given in figure 1 and Table I are the arithmetic means of the five shortest, or the five longest, survival times from the five replicate experiments. Table I includes the arithmetic means not shown by the curves in figure 1.

Twelve arithmetic means, each a mean of the five shortest survival times in experiments 5 A through 5 E of the previous paper, are plotted against injected concentrations (curve *S*) in figure 1. An analogous curve (*L*) for the long survival times is also shown. The open circles are the mean observed survival times and the solid dots are survival times calculated according to equation (14) of the previous paper, i.e.,

$$t_s = \frac{K}{n-1}\left\{\frac{1}{\left(\left[pc + c(1-p)\left(\frac{c_d}{c}\right)^m\right] - c_o\right)^{n-1}}\right\} + a. \ldots\ldots (14)$$

where c = concentration of poison injected, t_s = survival time, $\left[pc + c(1-p)\left(\frac{c_d}{c}\right)^m\right]$ = c corrected for dissociation, c_0 = minimum lethal concentration (approximately), and K, p, c_d, m, n, and a are constants. The values of the constants that had to be used to get these fits are given in Table II along with their values used to fit the harmonic means in the previous paper, which are given for comparison.

TABLE I

ARITHMETIC MEANS OF SHORTEST AND LONGEST SURVIVAL TIMES NOT SHOWN IN FIGURE 1, AS WELL AS SEVERAL, IN PARENTHESES, THAT ARE SHOWN IN FIGURE 1

CONCENTRATION		SURVIVAL TIME (minutes)	
Gm./100 ml.	Molar	Shortest	Longest
0.025	0.01923	(378)	(1,174)
.20	.01538	(538)	28,080
.15	.01154	(936)	58,320
.10	.007692	14,321	71,856
.075	.005769	13,200	66,960
.050	.003846	18,528	86,544
.025	.001923	23,040	66,750
Controls	....	22,464	69,264

TABLE II

VALUES OF CONSTANTS USED IN THIS ANALYSIS OF SURVIVAL TIMES OF ARSENITE-INJECTED ROACHES

CONSTANT IN EQUATION (14)	VALUE OF CONSTANT USED IN FITTING CURVE OF		
	Shortest Survival Time	Harmonic Means, Experiment 5 F of Previous Paper[1]	Longest Survival Time
n	4	4	4
a	4	5	6
p	0.62	0.48	0.44
c_d	.01694	.02203	.02870
n	3.25	2.5	1.75
c_0	.0002	.0005	.003
K	.0078	.0117	.0213
$\frac{K}{n-1}$	.0026	.0039	.0071
$\frac{n-1}{K}$	385	256	141

[1] These values, used to fit the harmonic means in the preceding paper (1), are inserted here merely for comparison. Corresponding values for the arithmetic means (entire data) are not very different from these.

Figure 2 shows curves obtained by plotting molar concentration (injected) against values of $100\left[p + (1 - p)\left(\frac{c_d}{c}\right)^m\right]$, calculated for the shortest and the longest survival times by use of the values of constants given in Table II. These curves are interpreted as curves of dissociation of the sodium metarsenite in the blood of those insects that had the shortest (curve *S*) and those that had the longest (curve *L*) survival times.

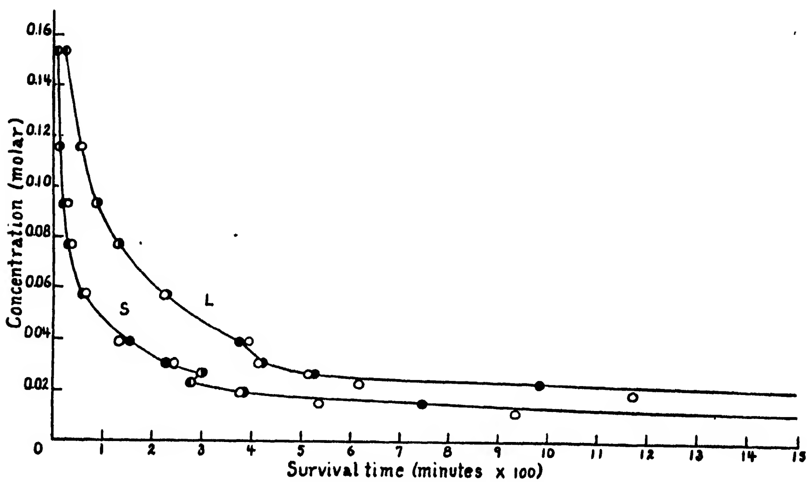

FIG. 1. Concentration-survival time curves for insects having shortest (curve *S*) and longest (curve *L*) survival times in experiments 5 A–E of the previous paper. Circles are observed survival times and black dots are calculated survival times.

DISCUSSION

Before discussing the meaning that may be attributed to the values in Table II, the physical significance of the constants will be stated briefly in terms of the hypothesis presented in detail in the previous paper. The period following injection, during which the injected poison is mixed with and distributed by the blood, is the latent period. Since this is included in the minimum survival time, *a*, it should tend to cause the latter to vary inversely with rate of circulation and other factors responsible for mixing and distributing the poison. The constant p represents the degree of dissociation of the poison at the end of the latent period following the injection of a maximum concentration. Other things remaining the same, p should increase with an increase in blood volume and might either increase or decrease with any variation

in the chemical composition of the plasma. The highest injected concentration that corresponds to complete dissociation of the poison in the blood is represented by c_d. This also should increase with increase of blood volume and might alter either way with change in plasma composition. The rate of shifting from molecular to ionic state as injected concentration changes and as poisoning progresses, i.e., as concentration of the poison in the blood changes, is represented in part at least by the exponent m. The value of m would alter one way or the other depending upon the various factors already men-

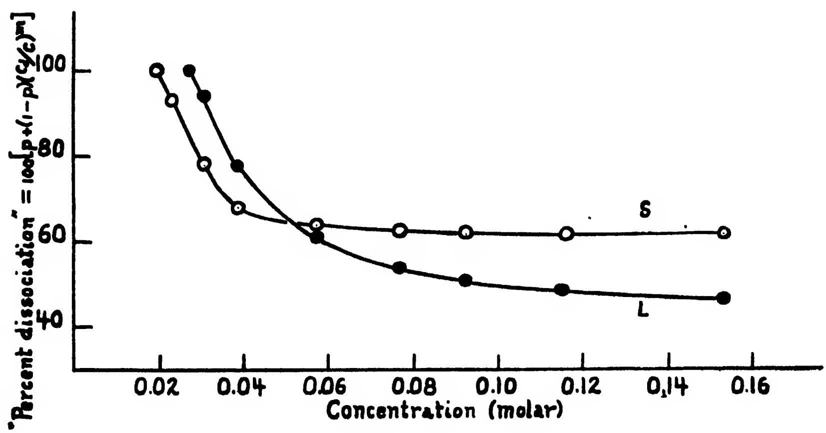

FIG. 2. Concentration (molar) plotted against $100\left[p + (1-p)\left(\frac{c_d}{c}\right)^m\right]$ to get what are regarded as percent dissociation curves of the poison in the insect blood. Circles and dots are for insects having shortest and longest survival times, respectively.

tioned. The part of the dosage that is rendered noneffective through excretion, detoxification, and other processes is included in c_o, which also includes sublethal quantities of the poison that combine with tissue component. The value of c_o would be greater when these antitoxic processes are greater. The constant $\frac{n-1}{K}$ may be used as an index of speed of toxic action per unit concentration factor, since

$$\frac{n-1}{K} = \frac{1}{t_s - a} \Big/ (c^1)^{n-1}$$

where $(c^1)^{n-1}$ is the concentration factor and

$$c^1 = \left(\left[pc + c(1-p)\left(\frac{c_d}{c}\right)^m\right] - c_o\right)$$

is the effective injected concentration, corrected for dissociation, and represents total concentration of ions. The constant $\frac{n-1}{K}$, of course, is greater for the shortest survival time curve (*S*, fig. 1; Table II).

Examination of figure 1 and table II shows that c_d has a higher value when survival time is long (curve *L*) than when it is short (curve *S*). This indicates that the dissociation of the poison in the blood reached completion at a higher injected concentration in the insects that had the longer survival times. On the other hand, p is lower for the insects with the long survival times, indicating that the degree of dissociation at the end of the latent period following the injection of the maximum concentration was less for the longer survival time. If the insects that had the longer survival times lived longer because the injected poison was diluted more by a larger blood volume, and if this was the sole difference between the two groups of insects, then both c_d and p should have higher values for the insects that lived longer. But, as shown, such is not the case. Although the two groups of insects may differ as regards blood volume, it is apparent that other factors are also operative.

The chemical constitution of the insect blood plasma, as well as certain other factors, may be expected to influence dissociation of the poison in the blood. It is reasonable to suppose that the combined influence of such factors would cause the insects having shorter and longer survival times to differ in the way in which the dissociation of the poison in the blood changes with a change in concentration. In other words, the combined effect of these factors would cause m to have different values for the two groups of insects. As shown in Table II, m has a higher value for the insects with the short than those with the longer survival times. As shown in figure 2, the curvature of the dissociation curve is greater for insects having short (curve *S*) than for those having long (curve *L*) survival times. This means that the shift from molecular to ionic state that is associated with a fall in concentration was more gradual in the insects that lived longest. Thus, whereas the association of long survival time and higher c_d value could be accounted for on the basis of the insects with the long survival times having a larger blood volume, the low values of p and m for these insects indicate that other factors must be acting in such a way as to depress dissociation of the poison at high dosages and to affect the rate of change of dissociation of the poison as concentration becomes less. These differences in p and m might reasonably be expected to result from differences in the composition of the plasma.

The value of c_o is extremely low for the insects that had the short

survival times and is much greater for the insects with the long survival times. This indicates that the latter were able to live for the longer time, either because they could detoxify or excrete a greater amount of the poison or because they possessed more vital tissue, or both.

As is to be expected, the $\frac{n-1}{K}$ values indicate that the relative speed of toxic action is greater when survival time is shorter.

Too much significance should not be attributed to the differences in the value of a. The tendency of a to be higher for the longer survival time, however, suggests that the mixing of the injected poison with the blood tends to be slower in the insects that have the longer survival times.

Examination of the concentration-survival time curves for the insects that had shortest and those that had the longest survival times in the other experiments of the previous paper reveals that those data are also in agreement with this analysis. It is of interest that in all of the curves the inflection appeared more marked in the curves of the shortest than in those of the longest survival times.

SUMMARY AND CONCLUSIONS

Further analysis of the data in a previous paper (1) has led to certain indications of the reason why some cockroaches injected with a given dose of sodium metarsenite survived for short times, whereas other roaches injected with an equal dose of the poison survived longer. An interpretation of the results of this analysis indicates that such differences in survival times are associated with and may in part be caused by:

(1) Differences in the electrolytic dissociation of the poison in the blood of the insects. These differences in dissociation may involve differences in (A) the degree of dissociation at high concentrations, (B) the rate of change of degree of dissociation with change of concentration, and (C) the concentration at which complete dissociation is attained.

(2) Differences in the capacity of the insect to render ineffective some of the poison that it received, differences in quantity of vital tissues, or differences in both.

It is suggested that among the physiological factors that may be involved in (1) are blood volume and chemical composition of the plasma and in (2) are processes of detoxification and excretion.

These results are also in accord with the idea that the mixing of the poison with and its distribution by the blood occur more slowly in those insects that have longer survival times.

The inflection appears to be more marked in the short than in the long survival-time curves.

LITERATURE CITED

(1) **Yeager, J. Franklin,** and **Munson, Sam C.** 1945. A study of the relation between poison concentration and survival time of roaches injected with sodium metarsenite. Ann. Ent. Soc. Amer. XXXVIII (4), 559–600.

CONTRIBUTIONS TO THE GENETICS, TAXONOMY, AND ECOLOGY OF DROSOPHILA PSEUDOOBSCURA AND ITS RELATIVES, by TH. DOBZHANSKY and CARL EPLING. Carnegie Institution of Washington Publication 554; 183 pages, Washington, D. C., 1944.

This important addition to the extensive literature of the genus *Drosophila* is made up of three articles: Taxonomy, Geographic Distribution, and Ecology of *Drosophila pseudoobscura* and Its Relatives by both authors, Chromosomal Races in *Drosophila pseudoobscura* and *Drosophila persimilis* by DR. DOBZHANSKY, and the Historical Background by DR. EPLING.

The first of the three articles includes the description of *Drosophila persimilis* as a new species, including the usual description of morphology and in addition the chromosomal peculiarities which the authors use as the ultimate basis of distinction. The reviewer is impelled to reiterate here an omission which he has previously stated regarding such descriptions, viz., that type material is not designated. The authors state their attitude on the nature and recognition of species fully, and certainly no taxonomist will disagree with them that the methods of taxonomy change nor that they must differ in various groups. They err seriously in stating that nomenclature has been devised primarily for the purpose of labelling specimens. Undoubtedly that is one end, possibly the only end for many collectors, but certainly the real purpose is to distinguish the many kinds of living things and to furnish a dependable medium for the exchange of information concerning them. Just as the discovery of genitalic differences in closely related species was a milestone in systematic entomology, so the recognition of chromosomal differences may take its place as an important discovery. But whatever the basis of a species, the material on which it is founded should be preserved and its location should be made known for the benefit of future generations of scientists. The great care expended in the safeguarding of type material has not been merely part of a fascinating game but a procedure whose value is known through sad experience.

The remainder of the first article is of interest both to geneticists and ecologists, while the second article presents very interesting problems in the bearing of cytological distinctions on questions usually treated by the taxonomist. This latter study should be read by all systematists who are concerned with the deeper significance of their subject in the origin and continuing evolution of taxonomic categories.

The third article is not historical in the true sense of the word, but deals with the geographic distribution of different gene arrangements in the species discussed and their probable phylogeny. Although such studies, whether based upon macroscopic characters or upon cytological minutiae, involve a considerable element of speculation, they are an important contribution to our understanding of evolutionary progress and possibly of evolutionary processes. This aspect of the writers' work appeals to the reviewer as one of the most promising contacts between genetics and evolution. Possibly, in time, Dr. Epling's phylads may lead us to the actual making of species. Possibly, too, these species may be of the traditional kind, as well as those which differ only in genetic constitution.

Meanwhile both evolutionists and taxonomists should recognize that this contribution, even though it deals with *Drosophila*, is as important to them as to geneticists.—A. W. L.

CONTRIBUIÇAO AO CONHECIMENTO DO GÊNERO SALYAVATA, (HEMIPTERA: REDUVIIDAE), by PETER WYGODZINSKY. 27 pages, including 13 of figures. 1943. Bulletin No. 6.

ALGUNS TIPOS DE GENEROS DA ORDEM LEPIDOPTERA. QUINTA NOTA: HETEROCERA, FAM. HEMILEUCIDAE, by R. FERREIRA D'ALMEIDA. 10 pages. 1943. Bulletin No. 7.

PARADAEMONIA RUSCHII NOVA ESPECIE (LEPIDOPTERA, ARSENURINAE), by JOSE OITICICA FILHO. 15 pages, including 8 of figures. 1943. Bulletin No. 8.

ALGUNS TIPOS DE GENEROS DA ORDEM LEPIDOPTERA. QUARTA NOTA: HETEROCERA, FAM. MIMALLONIDAE, by R. FERREIRA D'ALMEIDA. 6 pages. Bulletin No. 10.

ADELOCEPHALINAE DA COLECAO JULIUS ARP, by LAURO TRAVASSOS and EDUARDO MAY. 22 pages, 2 plates. 1943. Bulletin No. 11.

NOTA SOBRE DYSDAEMONIA TIMUR WEYMER (ms.) IN FASSL, 1915. (LEPIDOPTERA, ARSENURINAE.), by JOSE OITICICA FILHO. 12 pages, including 5 of figures. 1944. Bulletin No. 14.

SOBRE A ESPÉCIE CALLIONIMA (1) PAN (CRAMER, 1779) (LEPIDOPTERA, SPHINGIDAE), by JOSE OITICICA FILHO. 29 pages, 10 figures. 1944. Bulletin No. 21.

ALGUMAS ARANHAS DA REGIAO AMAZÔNICA, by CANDIDO DE MELLO-LEITAO. 12 pages. 1944. Bulletin No. 25.

ESTUDOS SOBRE AUTOMERINAE (LEPIDOPTERA). ESTUDO N. 1—SÔBRE O. TIPO DO GÊNERO GAMELIA HÜBNER, (1819), by JOSE OITICICA FILHO. 18 pages, including 5 of figures. 1944. Bulletin No. 26.

NOTA SUPLEMENTAR A "REVISAO DO GÊNERO PHOEBIS HUEBNER," by R. FERREIRA D'ALMEIDA. 16 pages. 1944. Bulletin No. 27.

VICTORWITHIUS MONOPLACOPHORUS N. GEN., N. SP. DA SUBFAMILIA WITHIINAE CHAMBERLIN, 1931. (PSEUDOSCORPIONES: CHELIFERIDAE), by JOSE LACERDA DE ARAUJO FEIO. 7 pages, including 3 of figures. 1944. Bulletin No. 28.

The foregoing titles are those pertaining to Arthropoda in a lot recently received from the National Museum of Brazil at Rio de Janeiro, under the title Boletim do Museu Nacional, Nova Serie. These publications are among the best received from South America in general quality of paper, typography and illustrations; in all of these points they meet high standards of excellence. Judging by the range of titles, which extend to fishes, amphibians and birds among those not mentioned here, the staff of the Museum is making comprehensive progress in the study of the vast Brazilian fauna. Its findings should be valuable to taxonomists of North America who struggle with the same problems. The bulletins listed include descriptions of some new genera and species, hence they will be needed by specialists in the several groups.—A. W. L.

ENTOMA, A DIRECTORY OF INSECT AND PLANT PEST CONTROL, Sixth Edition, 320 pages. Edited by G. S. LANGFORD. Published by the Eastern Branch of the American Association of Economic Entomologists, College Park, Md., 1945. Price $1.00.

Entoma is probably a familiar item to all entomologists engaged directly in economic work. To them and to the rest of our profession it cannot fail to be an exceedingly useful compendium of information on sources of supply of the many materials used in insect control. The treatment includes information on the nature and use of insecticides and fungicides with convenient dilution tables and conversion tables of weights and measures. Following this section poisons and accessory materials are listed alphabetically and under each the manufacturers producing it. The next section includes entomological supplies and equipment, treated in the same way. Several shorter lists include entomological services, motion pictures, organization of national and state agricultural departments and their divisions related to entomology, publications, societies, dealers, commercial insect control organizations, trademarked preparations and manufacturers. An index to the numerous advertisers completes the volume.—A. W. L.

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ENTOMOLOGY IN CHINA[1]

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The subject of Entomology in China presents a somewhat anomalous combination of the old and the new: time-honored customs and methods fresh from the modern laboratory. China, while it is the point of origin of many of our sciences, is also one of the areas of greatest backwardness, in the modern sense, among the larger nations of the world. At least the latter would no doubt be the impression received by an entomologist from this country in traveling through many parts of China today. Thus entomology in China, a land of contrasts, includes a peculiar mixture of ancient and modern practices. For instance, in the same area one might find farmers burning joss sticks before a shrine or shooting off firecrackers for the general protection of their crops from insects, weather or other destructive forces; other farmers picking or sweeping certain pests from their crops with their hands or home-made implements; and students or extension workers doing small-scale testing of insecticides on the same crops.

Early Entomology.—The Chinese people have, of course, made some of the earliest discoveries in the field of entomology, if not most or all of the first discoveries. History shows that the Chinese unquestionably first domesticated the silk worm. They have also brought other silk moths to a state of semi-domestication. Dr. Van Dyke informs me that in the sacred Chin Shan range of southeastern Manchuria he saw Chinese transferring submature larvae, probably of *Antheraea*, in large numbers on trays from one feeding area to another as the scrub oak foliage was consumed. The honey-bee may have been domesticated in China as early as it was in Egypt. The hives still used almost throughout the country are of primitive types, consisting of hollowed sections of logs such as palm trunks, or baskets made of woven bamboo. Chinese white wax, made from the Pela scale, *Ericerus pela*, is an ancient dis-

[1]I gratefully acknowledge the assistance of A. M. Boring, H. F. Chu, W. E. Hoffmann, T. Y. Hsiao, C. S. Lee, Y. P. Sun and E. C. Van Dyke in supplying certain information.

covery; its production has been encouraged during the war (Chiao & Peng, 1943), just as has silkworm raising.

Various insects are used in China for food to this day. These include giant water bugs (*Lethocerus*), large water beetles (*Cybister*), social wasp larvae and pupae, and "bees" (Steward & Cheo, 1937). The water bugs and beetles are commonly seen sold in the streets of Canton and Hong Kong. Quite a number of different types of insects, both larvae and adults, are sold in certain markets in Canton and elsewhere to serve as food for cage birds, since many of the beautiful birds the Chinese like to keep in cages are insectivorous.

A number of insects have been used as drugs in China. Among these are *Chu Ki*, a fulgorid, *Lycorma delicatula* (Liu, 1939-a), the nymphal shed skins of various species of cicadas, and the dog-fly, *Hippobosca longipennis*. For smallpox the latter are soaked in wine and drunk with the wine; for malaria the flies' appendages are removed and the bodies are made into pills with dough and taken on the morning of the day the next attack is due, vomiting being necessary to make the treatment successful (Bequaert, 1939). Dried dragon flies, cockroaches, cicada nymphs killed by fungus (*Cordyceps*) and other insects also form a part of the Chinese *materia medica*. The cockroaches, when eaten, are said to rid children of intestinal worms. (A parasitologist could hardly refrain from reacting to this by saying that if the child didn't already have worms before taking the treatment, he certainly should afterwards.)

Insects are also used as a source of entertainment in China. Crickets have been used in China for fighting exhibitions and gambling since 960 A. D. or longer. Special equipment has been developed for catching the crickets, housing them in summer and winter, day and night; for female oviposition, for feeding, for exciting them to fight and for cleaning their cages. All of this equipment is elaborately carved or molded of ivory, jade, special wood, porcelain or other materials. One type of container for winter quarters was made by an elaborate technique, no longer practiced, of forcing gourds to grow in various shapes with special patterns in relief on them by introducing the flowers into earthenware molds.

Raising these insects is a regular profession; people may have rooms full of stacked jars in which the crickets are reared, with a resulting din. Some wealthy people employ their own cricket experts. The crickets' wings are often thinly coated with wax to improve the sound. This is done by means of a blunt needle. Champion fighters are bred by artificial selection. They are fed on gorged mosquitoes and are given special treatment during sickness. A champion may be worth as much as a horse; at death it is buried in a special coffin with ceremony. (Laufer, 1937).

Various species of singing insects, such as crickets and long-horned grasshoppers (katydids) of various types are sold in miniature cages to take home and hang up in the house, so that their singing may be enjoyed. This custom is said to have arisen about 618 A. D. Crickets are mentioned in the earliest collection of Chinese popular songs (*Shi-king*). The insects are fed with sliced cucumber or lettuce in summer and masticated chestnuts and yellow beans in winter, the

feeding differing for the various species. Species caged for singing or fighting include the crickets *Gryllus conspersus* and *G. mitratus*, *Homoeogryllus japonicus*, *Loxoblemmus taicoun* and *Oecanthus rufescens*, and the katydids *Gampsocleis inflata* and *G. gratiosa infuscata*.

Cicadas are mentioned in Chinese literature at least since 500 B. C. There is an old custom of placing a jade cicada in the mouth of a corpse upon burial to help the soul in leaving the body. This custom is said to have arisen because of the observation of cicada metamorphosis and of the adults coming out of the earth. These tongue-amulets can still be bought in Canton and elsewhere. It is said that in the past cicadas have been caged as singers. Certain of the Chinese species do have songs that can be appreciated.

In the Shang Dynasty (1766–1122 B. C.) cicadas already held a regular place in Chinese decorative art (Myers, p. 4). Cicadas as well as many other insects feature prominently in Chinese art, including paintings, embroidery, porcelain, woodcarving and jade and other stone images. Many of the representations of insects, such as butterflies, moths, beetles, katydids, mantids, honey-bees and others, particularly those painted on silk or paper, can be definitely identified to the species. Most of the paintings the writer has seen could be placed rather easily. Sowerby (1940) has discussed insects in Chinese art.

Fireflies were a source of entertainment in China at least as early as 616 A. D., tremendous quantities being gathered and liberated when the emperor climbed to the top of a hill on a certain evening to view the sight. Fireflies are still collected by Chinese children and placed in empty egg-shells (Liu, 1939-a). Rhinoceros beetles (*Xylotrupes dichotomus*, *X. gideon*), stag-beetles, june-beetles, bamboo weevils (*Macrocheirus longipes*), lantern flies (*Fulgora candelaria*) and others are caught by children and tied to stones or bamboo sticks with lengths of string, for amusement. Certain of the larger buprestids, such as *Chrysochroa fulgidissima*, are used as ornaments.

Dr. Gaines Liu (1939-b) has described what he calls the "earliest Bureau of Entomology," the plans for which were outlined probably in the 12th century B. C. The proposal included personnel, function and methods under each of five divisions: (1) insect borers, (2) household pests, (3) frog control, (4) aquatic vermin, and (5) poisonous *Ku* (probably internal parasites). Though some of the control methods involved propitiation, others included fumigation or spraying with plant products.

A number of primitive methods of insect control are used in all parts of China to this day. I have seen farmers in northern Formosa using specially constructed basket-like nets of woven bamboo on bamboo handles swung like a sweeping net through the tops of growing rice plants to collect the adults and larvae of the leaf beetle *Lema oryzae* and adults of *Hispa*. These leaf-beetles are important rice pests in South China and Formosa. It is a common sight throughout the same regions to see large flocks of ducks being slowly driven through the rice paddies to feed on the insects, snails and crustaceans that inhabit them. Geese and chickens are to some extent used for the same purpose.

Prof. Hoffmann (1935) reports than in an out-of-the-way locality in Kwangtung Province he found a method of white-grub control which consisted of placing bunches of old rice-straw containing dirt up among

the branches of trees. This provides a highly suitable egg-laying site for the june-beetles, and after the laying season is over the bundles of straw are taken from the trees and burned, thus destroying the larvae and eggs. Dr. Van Dyke tells me of finding a farmer near Nanking busily occupied digging up the wire-worms and adults of the click-beetle *Pleonomus canaliculatus* from around the bases of bean plants in a field. Methods such as these and others indicate a close familiarity with the habits of the agricultural pests on the part of the Chinese farmers; on the other hand, some practices or lack of certain precautions indicate lack of knowledge or mistaken ideas regarding other insects. Many measures for control are used which involve simple mechanical methods such as collecting or killing. Even entomologists are forced to make control recommendations of this sort for farmers. The Canton Government has in the past paid bounties for extensive collecting of Lychee stink-bugs, and at Lingnan University we have to a considerable extent satisfactorily advocated the hand-picking of certain insect pests, the catching of june-beetles at night by attracting them with the light of torches, the use of wires and tools for the destruction of termite nests and for extracting long-horned beetle larvae from trunks of living fruit-trees, as well as cultural methods (Hoffmann, 1934; Gressitt, 1942-a). Many cultural techniques have been gradually evolved by the Chinese farmers in response to the attacks of insects on their crops, though there is still much room for advancement.

The earliest record of biological control of insects is found in Chinese literature of about 900 A. D.; and the species referred to, the Citrus Red Ant, *Oecophylla smaragdina* Fabr., is still used in South China for the control of *Citrus* pests (Groff & Howard, 1924; Liu, 1939-a; Gressitt, 1942-a). The nests are annually brought from the hills in bags and sold in the markets of the Canton delta to the orchardists, who place them in the *Citrus* trees. The nests are made of leaves and silk-like material, and occur naturally in the branches or crotches of trees. The ant is red, about one-half inch long, has long legs, and is very ferocious. I suffered considerable inconvenience from the bites of this species while collecting parasites of the red scale insect in Hong Kong and Canton for the University of California Citrus Experiment Station during 1940 and 1941. There is some question in the writer's mind about the value of this species, since it tends certain unarmored scale insects, as do many ants. However it undoubtedly discourages many pests because of its predaceous habits. Another ant, a smaller, less vicious, black species, is also found in the orchards, no doubt naturally. Its nest is built entirely of paper-like material, being stiffer and heavier than most wasp nests; it is found in the upper or outer branches of the trees. Being less predatory, its value is probably even more doubtful.

There is a general impression among the Cantonese that the presence of certain black ants around houses will prevent the inroads of termites; but this is questionable, at least as far as generalizations are concerned, until all the ant species have been evaluated.

The chemical control of insects also apparently had its beginnings in China, probably at least as early as the 12th century B. C. (Liu, 1939-b). The methods of the "earliest Bureau of Entomology" included fumigation with *Illicium anisatum* and spraying with the ashes of *Chrysanthe-*

mum (pyrethrum), as well as the use of lime. The first is still used in South China. At the present time in some parts of China tobacco stubs are planted with individual rice transplants to combat the paddy borer, and scientific tests have shown control and increased yield. In Canton rings of tobacco ash mixed with cigaret stubs surrounding young transplants seemed to have some beneficial effect against cut-worms. This was tried in the Canton internment camp where no other insecticide was available. The milky juice from crushed fresh *Derris* roots has been used for centuries as an insecticide by the Chinese (Roark, 1931). The natives on Hainan Island and elsewhere have used *Derris* as a fish poison since early times. In Kwangsi Province fire-crackers have been used to combat tree borers. The crackers are fired in the burrows and the outer openings sealed promptly to retain the fumes.

Entomology in Modern China.—To one going to some of the usual sources dealing with history of entomology to seek for information on entomology in China, it might prove a revelation to find that no mention at all is made of China in such a book as L. O. Howard's "History of Applied Entomology." And this in spite of the fact that nine pages are devoted to Japan and 28 to Asia exclusive of the Philippines.

In attempting to explain this briefly, it might be said that the backwardness of China in entomology is largely a reflection of the delayed unification of the nation, the relatively low economic level of so much of the country, the inadequate financing of government programs, education and research, the high illiteracy, and such handicaps. However, to be quite fair it must be emphasized that rapid advancement is taking place at the present time, in spite of the added difficulties during the war.

It might be stated that modern entomology began to develop in China only about a quarter of a century ago. The first organized scientific control measures were inaugurated in 1917 when egg-mass collecting of the rice-borer (*Schoenobius incertellus*) was begun in eastern China. In 1920 a field station was established by the National Southeastern University for the study of the cotton geometrid (***Boarmia***), and in 1922 this was superseded by the Bureau of Entomology of Kiangsu Province, organized at Nanking with Prof. C. W. Woodworth as the first director (Woo & Hsu, 1935). Also in 1922 the ***Lingnan*** *Science Journal* (then the *Lingnaam Agricultural Review*) commenced publication. This is the oldest and best known periodical in China dealing primarily with the biological and agricultural sciences. In 1924 the Chekiang Bureau of Entomology was established, and in 1926 the *Peking Natural History Bulletin* started publication. The Department of Entomology and Plant Pathology of the National Agriculture Research Bureau was organized at Nanking in 1933, after the abolishment in 1932 of the Kiangsu Bureau of Entomology, mentioned above.

The first modern entomological paper known to me to be published in China was an article on sericulture by C. W. Howard (1922) of Lingnan University, which appeared in the first number of the ***Lingnan*** *Science Journal.* A short entomological note also appeared in the same issue (Campbell, 1922). Of course many Chinese insects had previously been described in European literature, even back to the

time of Linnaeus. Summarizing an analysis made a decade ago (Ouchi, 1934-b), it may be said that the numbers of entomologists having published on Chinese insects, arranged by countries, place the important contributing nations in the following order: (1) Germany, (2) England, (3) France, (4) Austria, (5) Russia, (6) China, (7) U. S. A., (8) Belgium, (9) Holland, (10) Italy, (11) Hungary, (12) Sweden and (13) Japan. The important countries arranged in the order of numbers of Chinese insect species described by specialists of those countries are: (1) England, (2) France, (3) Germany, (4) Russia, (5) Belgium, (6) Austria, (7) U. S. A., (8) Roumania, (9) China, (10) Holland, (11) Italy, (12) Czechoslovakia, and (13) Hungary, with Japan 18th on the list. The work done during the past decade would raise slightly the relative position of China, Japan and the United States on these lists. As to work actually published in China, the three ranking nations are China, the United States, and France.

As far as the encouragement and furthering of entomology in China by other countries is concerned, the United States has been the main contributor, with France second. Much of this contribution has been made through the colleges in China originated by Americans, notably Lingnan University, Yenching University and the University of Nanking. Chinese entomologists have expressed to me their feeling that the person who has contributed the most to entomology in China is Professor William E. Hoffmann of Lingnan University, through his long editorship of the *Lingnan Science Journal*, his work on economic insects in China, and his building up of the Lingnan Natural History Survey and Museum, as well as his teaching and advisory activities. Other American entomologists who have taught and helped organize work in China include Prof. C. W. Woodworth, Dr. C. W. Howard, Dr. J. G. Needham, Dr. W. A. Riley, Dr. E. C. Van Dyke, Prof. C. R. Kellogg, Prof. B. A. Slocum and Prof. A. W. March. The last two are still in China.

The French have built up two of the best museums in China: Musée Heude at the Université l'Aurore in Shanghai and Musée Hoang-Ho Pei-Ho in Tien-tsin, and have carried on teaching in the associated universities. The name of Rev. Father Octave Piel, of the former institution, will long be remembered in connection with Chinese entomology.

In discussing entomology in China particular mention should be made of Dr. C. F. Wu of Yenching University, well known for his many students, his catalogues of Chinese insects (1935–41) and his work on aquatic insects. Dr. Wu had his advanced training at Cornell University, as have many Chinese entomologists—another way in which Chinese entomology has profited by its association with the United States.

The principal institutions in China dealing with entomology are listed in Table I, together with entomologists and entomological publications connected with them.

Entomological articles appear in about 45 periodicals in China, published by about 35 institutions or societies. Entomological courses are taught in over 20 colleges or universities in China.

TABLE I

Institutions, Entomologists and Publications in China Dealing with Entomology[3]

Institutions	Entomologists	Publications	Languages used in Publications
Academia Sinica	S. H. Chen; Y.Y. Zia; B. Young	Sinesia	E, (C).
National Academy of Peiping	H. F. Chu	Zoologia Sinica	E, (C).
Fan Memorial Inst. Biol.	W. I. Yang	Bulletin (Zool. Ser.)	E.
National Agric. Res. Bur.	F. C. Woo; H. T. Feng; Gaines K. C. Liu; Gideon T. W. Liu; Y. P. Sun; T. S. Cheng; P. T. Sun; K. O. V. Lieu.	Special Publications Misc. Publications Nung Pao	C, E. C. C.
(Kiangsu Bureau Entom.)	(Discontinued)	Technical bulletin	C, (E).
Chekiang Bureau Entom. (Hangchow)	Y. H. Tsou; S. C. Wu	Entom. & Phytopath. Yearbooks Misc. Publ. (1930–)	C, (E). C, E. C, (E).
Kwangsi Agr. Exp. Sta.	C. Y. Liu; Y. F. Hsu; S. L. Hwang; S. N. Chiang	Kwangsi Agric	C.
Kwangtung Bur. Agr. & For.	K. S. Chan	Technical Bulletin	C, (E).
Nat. Peking Univ	....	....	....
Nat. Central U., Agr. Coll	T. L. Tsou	....	....
Nat. Tsinghua U. Agr. Coll	C. L. Liu; C. J. Luh; Y. T. Mao; H. Y. Fan	....	....
Nat. Chekiang U., Agr. Coll.	P. H. Tsai; T. C. Maa	Reports	C.
Nat. Shantung U., Agr. Coll.	....	....	....
Nat. Szechuan U., Agr. Coll	S. Tseng	....	....
Nat. Sun Yat-Sen U. Ag. Coll.	S. F. Chiu; S. Lin; S. Chui; Chow Yung	Sci. Reports	C, (E).
Lingnan U.; Lingnan Nat. Hist. Surv. & Mus.; Ag. Coll.; Biol. Dept.	W. E. Hoffmann; Y. C. Ng; Y. W. Djou; J. L. Gressitt; C. T. Cheng	Lingnan Sci. Jour. Lingnan Sci. Bulletin Lingnan Agr. Jour. Special Publ. N. H. Survey	E, (C). E. C, (E). E.
Yenching U., (Peking Nat. Hist. Soc.)	C. F. Wu; T. P. Chang; J.C. Li.	Peking Nat. Hist. Bulletin*	E.
U. Nanking, Coll. Agri.	B. A. Slocum; K. F. Chen; C. S. Tsi	Agric. Forestry News	C.
W. China Union U. (W. China Border Res. Soc.)	M. C. Chang; D. S. Pen	J.W.China Border Res.Soc.*	E, (C).
Fukien Christian U	C. R. Kellogg	Proc. Nat. Hist. Soc. Fukien Chr. U.	E, C.
Hangchow Christian Coll	A. R. March	....	....
Tung-wu U. (Soochow U.)	....	Biol. Supply Service Bull.	C, E.
St. John's U	....	Jour. St. John's Sci. Soc	E.
U. Hong Kong	C. S. Ng; S. W. Ling	Hong Kong Naturalist*	E.
Musee Heude (U. l'Aurore)	O. Piel; B. Becquart	Notes d'Ent. Chinoise	F, E.
Musee Hoangho-Peiho	....	....	....
China Soc. Arts & Sci.	....	China Jour. Arts & Sci.	E.
N. China Royal Asiatic Soc.	....	Jour. N. China Royal Asiatic Soc.	E.
Sci. Soc. China	....	Biol. Contr. Lab. Sci. Soc. China	E, (C).
Agric. Assoc. China	....	Jour. Ag. Assoc. China	C.
Nat. Med. Assoc. China	....	Nat. Med. Jour. China	E.
Chinese Med. Assoc.	....	Chinese Med. Jour.	E.
Henry Lester Inst. Med. Res.	S. M. K. Hu	....	....
Nat. Hist. Soc. China	....	Jour. Nat. Hist. Soc. China (?)	....
Shanghai Sci. Inst.	Y. Ouchi (Japanese)	Jour. Shanghai Sci. Inst.	E, C.

[3] E = English; C = Chinese; F = French. Parentheses indicate that the second language is used in abstracts, or for occasional articles. An asterisk indicates that it is not an official publication of the institution, though generally representing a society more or less associated with the institution. I must apologise for the many omissions in the table, and possibly some errors as well. A few of the above-listed entomologists are at present in the United States.

Agricultural Entomology.—The National Agriculture Research Bureau has one or more branch experiment stations in almost every province. Some of these are devoted to particular crops, and others deal with all types of local agricultural problems. Most of these have one or more entomologists attached to them. Much of the field work in agricultural entomology is carried on through these experiment stations and certain of the national or private universities.

The agricultural insect problems of China are too numerous to discuss or enumerate. Almost every one of the many crops has a number of insects attacking it in one way or another. Native plants, such as rice, *Citrus*, banana, tea, *Prunus*, lychee, mulberry, and others closely related to native plants, such as fig and various vegetables, are attacked by large numbers of insect species. Some of the pests attacking these are very serious pests in certain other countries where they have been accidentally introduced. Most of these latter are relatively less serious in China because they are naturally attacked by parasites or predators. Pests of stored food products are of very great importance, because of the common small-scale, essentially unprotected storage, and the importance of grains, such as rice, corn and wheat. It is practically impossible to keep dried fruit by ordinary methods in South China.

Knowledge of the agricultural insect pests of China is very incomplete. Though a fair amount of work has been done on certain species, many are very poorly known. In fact many are hardly known at all, or have not been identified. It is still possible to collect new species of moderately important economic insects in China. Much work of a pioneering nature remains to be done on the identification and biology, as well as control, of crop pests. Cheo (1936–7) published a list of agricultural insects of China which was admittedly preliminary in nature. Prof. Hoffmann has been working for some years on a host-catalogue of agricultural insects for South China. He has also published (1934) life-histories of many economic insects. At present Cecil S. Lee, at Cornell University, is preparing a list of Chinese agricultural insects. F. S. Li (1940) published a text in Chinese on economic entomology in China.

Among the most important insect pests of agriculture in China may be mentioned the following:

Locusta migratoria Linn. (Acridiidae)—On rice, corn, etc.
Tessarotoma papillosa Drury (Pentatomidae)—On lychee.
Nephotettix apicalis Drury (Cicadellidae)—On rice.
Aphis gossypii Glover (Aphididae)—On cotton.
Sitotroga cerealella Olivier (Gelechiidae)—In stored food.
Schoenobius incertellus Walker (Pyraliade)—On rice.
Chilo simplex Butler (Pyralidae)—On rice.
Cirphus unipunctata Haw. (Noctuidae)—On various food crops.
Pieris rapae Linn. (Pieridae)—On crucifers.
Melanauster chinensis Först. (Cerambycidae)—On citrus and other fruit trees.
Phaedon brassicae Baly (Chrysomelidae)—On crucifers.
Sitophilus granarius Linn. (Curculionidae)—In stored food products.
Cylas formicarius Fabr. (Curculionidae)—On sweet potato.

In the field of agricultural entomology, special mention must be made of Dr. F. C. Woo (1934–5), chief of the Department of Entomology and Plant Pathology of the National Agriculture Research Bureau, and a student of Dr. Van Dyke. S. F. Chiu (1934) discussed insect pests in Kwangtung Province. Woo and Cheng (1934) reported on locust outbreaks in China, and Woo and Hsu (1935) discussed the general subject of Chinese agricultural entomology.

The development of control methods for the many agricultural pests is still in the early stage, even though certain materials have been used since very early times, as indicated above, in addition to mechanical methods. Actual chemicals have not been very extensively used, though certain arsenicals have long been utilized to limited extents. More recently the following have been experimented with in particular: lead arsenate, calcium arsenate, copper carbonate and oil emulsions. Because of the relative scarcity of appropriate chemical materials in China and the financial inability of the farmers to purchase them even when available, the tendency has been to use available insecticidal plant products. In recent years, and particularly during the war, research has been directed towards finding practical plant materials accessible to the farmers. Some of the plants tested (Hwang, 1941; Chiu, *et al*, 1942; Hansberry & Lee, 1943, Lee & Hansberry, 1944) have been made use of in local areas for long periods by Chinese farmers.

Among the plant sources of insecticidal materials are the following: cottonseed-oil and rapeseed-oil, for emulsions against apids; resin wash for *Citrus* scales; Szechuan bean seed (*Croton tiglium* Linn.), sheep poison (*Rhododendron sinense* Sweet) and *R. mollei* G. Don., in the form of extract emulsions, used as stomach poisons for the mulberry white caterpillar and other leaf-eating insects. The leaves, root or bark of "Roy-kung-teng" (*Tripteryguim Wilfordii* Hooker), *T. Forrestii* Loes, *Celastrus angulatus* Maxim and *C. rugosa* R. & W. are used to make sprays or dusts for *Phaedon brassicae* Baly and other leaf-eating insects. Various extracts of *Derris uliginosa* Benth., *D. elliptca* Benth., *Millettia* pachycarpa Benth., *Pachyrrhizus erosus* Urban, *Chrysanthemum cinerariaefolium* Trev., *C. roseum* Wev., and *C. Marshallii* Ach. are used as both contact poisons and stomach poisons, particularly the former, for various types of insects.

Medical Entomology: The first discovery of primary importance in the field of medical entomology was made in China, when Sir Patrik Manson, at Amoy in 1878, proved that *Culex fatigans* transmitted *Filaria bancrofti* to human beings. However this field, at least up to the start of the Pacific war, has been rather neglected in spite of its importance in China where standards of hygiene and sanitation are low. Research work has been carried on in only a few areas and very little practical control of disease-disseminating insects has been carried out. Many important diseases in China are carried by insects. Among these are malaria, dengue, filariasis, plague, typhus, murine typhus, relapsing fever, dysentery, kala-azar, leishmaniasis, encephalitis, Japanese B. encephalitis, and papatasi fever. Scrub typhus, which is also arthropod-borne, may also occur.

In South China, malaria, dengue and filariasis are very important. Because of the importance of rice and the necessity of flooding the

paddies, special methods must be used to control paddy-breeding vectors like *Anopheles hyrcanus sinensis* Wied. Since night-soil is the most important fertilizer in most parts of the country, and since houses, toilets and food markets are not screened, the various germ-carrying muscoid flies are of great importance. Because of the abundance of rats, fleas and lice, plague and the various forms of typhus are potentially dangerous, and epidemics occur from time to time, especially during floods and wars. The number of insects of medical importance in China will prove to be very large. Many of them are still unnamed.

Among those who have carried on research in medical entomology in China, particular mention must be made of Stephen M. K. Hu, who has worked extensively with mosquitoes in the Shanghai area (Hu, 1939, etc.). In addition may be mentioned K. Chang (1943), T. L. Chang (1940), C. Y. Chow (1940), E. C. Faust (1929), C. H. Meng (1943), R. G. Mills (1925), W. S. Patton (1926), W. A. Riley (1932), C. C. Wu (Yao & Wu, 1938) and Y. T. Yao (1938).

Systematic Entomology: In this field, as pointed out above, much of the work to date has been done by foreigners, particularly Europeans. Though begun early, in the modern sense, very much remains to be done. I feel that the outstanding Chinese research worker is Dr. S. H. Chen of the Academia Sinica, who studied at the University of Paris, as did his wife, Y. Y. Zia, also a sound systematic entomologist. Both have worked in the Coleoptera and the Diptera.

Among the various specialists who have made particular contributions to the systematics of Chinese insects may be mentioned J. G. Needham (1930) on dragon-flies; S. F. Light (1924) on termites; K. S. F. Chang (1939), Morgan Hebard, J. A. G. Rehn (1941) and E. R. Tinkham (1937) on Orthoptera; W. I. Yang (1939), W. E. China (1940), W. E. Hoffmann (1935), T. Y. Hsiao (1942), C. J. Drake, H. B. Hungerford on Hemiptera; Z. P. Metcalf, W. D. Funkhouser, Gaines K. C. Liu and R. Takahashi on Homoptera; M. E. Mosely (1942) on Trichoptera; S. H. Chen (1934), L. Fairmaire, W. Horn, R. Kleine, E. A. Chapin and J. L. Gressitt (1940, 1942-b) on Coleoptera; C. P. Alexander on Tipulidae; Y. Y. Zia and S. H. Chen (1938) on Trypetidae; C. T. Cheng (1940) on Syrphidae; C. Y. Liu (1939) on fleas; and C. E. Mickel (1933) on Mutillidae.

Ouchi (1934-a) has compiled a bibliography of Chinese insects, though it is incomplete. In recent years Japanese have been describing fossil, as well as recent, insects from North China and Manchuria. Some of these species have been described in the Japanese language.

The unsolved problems and needs of entomology in China are very great. Undoubtedly American entomologists and institutions will aid in placing entomology in China on a firmer basis during the critical postwar period, when so much help will be needed. Much progress will undoubtedly be made towards solving the many problems, and we may look forward to mutually advantageous co-operation.

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OBSERVATIONS ON THE CELLULAR ENCLOSURES OF THE MID-GUT EPITHELIUM OF PERIPLANETA AMERICANA

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The following investigation was undertaken in order to determine the presence, form, and distribution of the mitochondria in the epithelial cells of the mid-gut of *Periplaneta americana.*

This investigation is being reported because of the variation in results between the observations of Gresson (1), on the mid-gut of another member of this genera, *Periplaneta orientalis* and these noted here on *Periplaneta americana.*

Several interesting studies have been conducted on the histological structure of the mid-gut of closely related genera by Breakey (2), and Patterson (3). There still remains a controversy over the exact method by which the formation of new epithelial cells takes place from the germinal centers in the mid-gut. The question of the presence of a striated border on the digestive epithelial cells also offers a topic of discussion. Both of these points of interest have been discussed in part in this report in view of offering a contribution to a general agreement among investigators on these issues.

MATERIALS AND METHODS

When this investigation was begun a large number of specimens was collected for dissection. All the material prepared for study was dissected under physiological saline and immediately placed in the fixing solutions. Only the mid-gut was used for study.

Tissues for general histological study were fixed in Bouin's fluid and stained in Azan and Iron Hematoxylin. Sections were cut at 6 microns in thickness mounted in series. For observations of the mitochondria Bensley's and Regaud's fixatives were used; the latter proved more satisfactory. The sections were cut at 2–4 microns (mu) and stained with Acid Fuchsin and Methyl Green.

Sections fixed and stained by the above methods offered an opportunity to study the position, etc., of mitochondria in relation to other cellular inclusions in similar cells. Considerable difficulty developed in the embedding of the tissue due to the presence of air in the tracheoles along the gut. This was overcome by extracting the air from the tissue by means of a suction flask before embedding. As the pressure in the flask was gradually increased the air was slowly removed from the tracheoles. The pressure was increased cautiously to insure no injury to the tissue.

All slides were observed with a monocular research microscope having a 12 X ocular and an oil immersion objective with a numerical aperature of 1.8, the combination of lenses giving a magnification of 1620. Cell drawings were made with aid of a camera lucida.

OBSERVATIONS AND DISCUSSION

MID-GUT

The inner layer of cells lining the mid-gut are epithelial cells of the columnar type, all elongated. The epithelium is folded. The cells are somewhat compressed along the basement membrane causing the nucleus to be of an oval shape. The free edges of the epithelial cells give the appearance of a brush border similar to the plateau as reported by Patterson (3). However, in the mid-gut epithelium as reported by this same author, there is no evidence of basal protoplasmic striations.

On the lumen side of the digestive epithelial cells are many granules. Certain cells show signs of rupturing their peripheral border. These cells are referred to as mature secretory cells. They have an abundance of secretion along the peripheral border causing a swelling of the cell in that region as shown in figs. 3 and 4. Those cells which appear to be degenerating in the epithelium and have completely lost all of their secretions slowly increase in size to maturity and pass through the same cycle. Evidence for the fact that these are still active living cells is that the nucleus appears to be normal at all stages, the nucleus being an indicator of the condition of the cell. Other secretory cells were observed which contained an abundance of very heavily stained granules. These cells were interpreted as one stage in the development of the mature secretory cell as shown in fig. 1. This type of cell was present in both the anterior and posterior of the gut.

The cells of the regenerative type were devoid of secretory granules. It appears that the secretion granules are present only in digestive cells. After the cell contents are discharged into the lumen they appear to degenerate. However, this is not the case as the cells in this state represent a stage in the functional cycle of the epithelial cells. This concept will be discussed later in this paper. There is no evidence of mitotic division among the large digestive cells. Regeneration appears to be entirely from the germinal centers. · There appears to be very little difference in the cells of the anterior and posterior mid-gut. However, the granules are more prevalent in the anterior region signifying the secretory function of the mature epithelial cells. Those in the posterior region are more of an absorptive nature since they have fewer granules.

It is difficult to say precisely what is the exact type of epithelium lining the gut. It may be of two types, simple or pseudostratified columnar. With further investigation into the evolution of the germinal centers it should be possible to state definitely the specific type of epithelium composing the entire inner lining of the mid-gut. Division may be vertical with all the cells maintaining their attachment with the basement membrane, resulting in all simple columnar epithelium. Division in the germinal centers or nidi may be of a horizontal nature resulting in a pseudostratified type of cell as shown in figs. 1 and 2.

The free edges of the epithelial cells are described by some authors as being serrated. This characteristic was not clearly defined in all cases. The serrations were most evident in cells which were stained heavily. These edges may be due to the great pressure to which the

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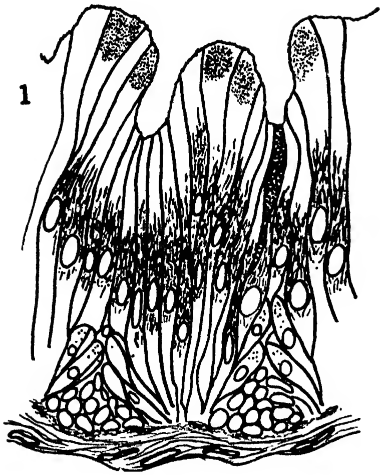

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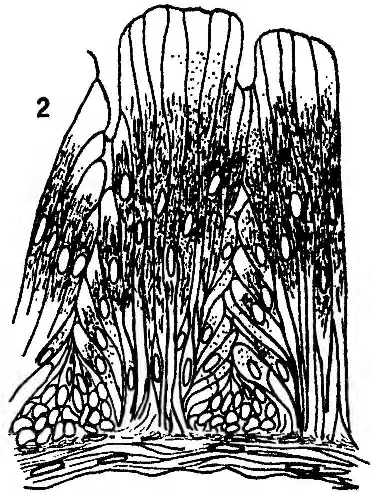

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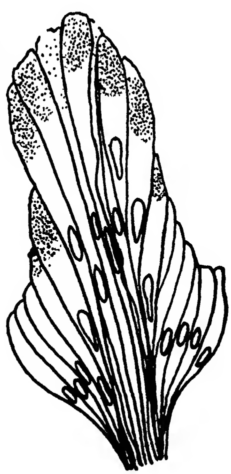

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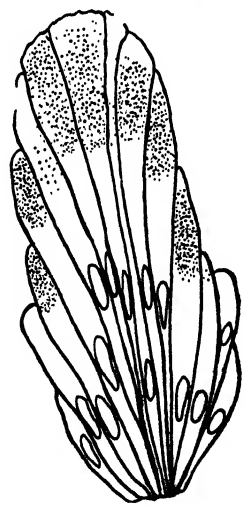

Fig. 1. A drawing of the midgut epithelium showing the position of the mitochondria, germinal centers, and secretory cells with large granules. Fig. 2. A drawing of the epithelium showing the mitochondria, and the formation of new cells. Fig. 3. A drawing of an epithelial crest showing the position of secretory granules and the ruptured free margins of several cells. Fig. 4. A drawing to show a group of active secretory cells indicated by the greater number of granules.

cell is exposed. Another interpretation is that the cells may be of the steriocilia type since no basal granules were evident.

Various regions along the epithelium in those cells of the digestive type exhibited an abundance of secretion within the cell along the lumen side. There were still other regions in which this characteristic was not evident. This phenomena may suggest periods of secretion alternate with periods of absorption in accordance with Gresson (1).

MITOCHONDRIA

Mitochondria are present in the epithelial cells of the mid-gut of the roach. They are in the form of rods, filaments and granules. They are distributed throughout the peripheral and middle regions of the cell; a few are on the basal side between the nucleus and the basement membranes as shown in fig. 2. There is no definite zonation of the mitochondria in these epithelial cells as reported by Woodruff, et al. In most of the young cells, which have not become digestive in their function, the mitochondria are scarce with the exception of a few granules at the periphery as shown in figs. 1 and 2. There is an abundance of large rods and filamentous mitochondria closely associated with the nucleus. On the peripheral side small granules appear around the globules of secretion at the edge of the cell next to the lumen as shown in figs. 3 and 4. Some authors identify these globules in the lumen of the cell as clumps of granular mitochondria. In a few of these cells the mitochondria are all long rods and no granules are present. The rods are located in the peripheral region of the cells. No secretion was noted in these cells.

In those cells which contain globules it is difficult to ascertain whether the globule is material absorbed or globules formed from the mitochondria. Supporting this later view is the fact that the globules are in close association with the granular mitochondria which are thought to be responsible for cellular secretion.

The rods are about one-half the length of the filaments. The granules vary considerably in size. The diameters of all three types of mitocondria are less than the identical types in hepatic cells of rats.

Secretory granules are present. Some authors, Gresson (1), identify spherical bodies with darkly stained borders located at the periphery of the cells. These structures are similar to secretory granules and are identified as developing secretory granules. In the author's observations these bodies were not identified. However, similar structures were observed in my observations on the mitochondria of hepatic cells of rats. These structures were also observed by other authors and were identified as spherical mitochondria functioning in the formation of glycogen, Noel (4). Patterson (3) also notes the presence of these spherical bodies in ***Passalus cornutus***. However, in order to give definite identification and action to these bodies more evidence is needed.

In addition to the closely associated work of Gresson (1), and the work of Woodruff (5), on the mitochondria in the mid-gut of the grasshopper, he describes them as long filaments in the base of the secretory cells, shorter ones in the central region and very short rods or granules distally; therefore he suggests that in this cell there is a situation

comparable to the secretory cycle observed in the thyroid cells of the albino rat.

Observations by Shinoda (6), in *Bombyx* coincide somewhat with the author's accounts on the roach. Shinoda (6) states that the mitochondria are evenly distributed and the secretory granules are heaped at the distal end of the cell.

The work of Patterson (3) on *Passalus cornutus* does not agree with the account of Shinoda (6). She explains that this is due to the fact that the epithelium in *Bombyx* is entirely different from that in a coleopteran, for there it consists of two morphologically distinct cells, cylindrical and goblet cells.

Mitochondria occur in the very distal end of the cells in the roach and silkworm. Patterson (3) does not report the presence of mitochondria in the distal end in *Passalus*. She describes the mitochondria as rods, filaments and granules. She also describes spherical granules as having clear centers closely related to the Golgi apparatus in those sections fixed with osmic acid. The method of secretion is probably the same that occurs in Orthoptera where there are no true goblet cells but more information must be had before definite conclusion can be drawn concerning the relationship between the mitochondria and different secretory phases.

CONCLUSION

1. The paper notes observations of the mitochondria in the mid-gut epithelium of the roach, *Periplanta americana*.
2. There are two types of cells: secretory and absorptive.
3. Mitochondria consists of rods, filaments and granules.
4. Mitochondria persist chiefly as filaments and rods in the mature cells.
5. Granular mitochondria are present in the regenerative cells.
6. It is thought that the epithelial cells tend to go through a secretive and an absorptive cycle.
7. Mitochondria persist in the middle and peripheral regions of the cell; most abundant in the region of the nucleus.

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NOTES ON THE SYNONYMY AND CLASSIFICATION OF THE ENICOCEPHALIDAE

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In my recent "Classification of the Enicocephalidae" (ANNALS of the Entomological Society of America, 38 : 321, 1945) it was explained by footnote that no copy of Jeannel's recent monograph of this group of insects (Annales de la Société Entomologique de France, CX, p. 273, 1942) had reached this country because of the war. Through the kindness of Dr. R. I. Sailer I have now seen a copy of this important work. It is most unfortunate that this long neglected group should have been revised simultaneously by two authors, each working entirely independently. On the other hand some benefit has been derived from this procedure because Jeannel, although working without access to the Scandinavian, British, American, Pacific and Oriental types and other material which I studied, nevertheless, had access to types from continental collections which were inaccessible to me and some of which may now be destroyed.

The only straight synonyms created in my paper are *Pseudenicocephalus* Usinger, 1945, (type *Henicocephalus lewisi* Distant) which equals *Hoplitocoris* Jeannel, 1942, (type *Henicocephalus kenyensis* Jeannel) and *Ceratotrachelus* Usinger, 1945, (type *Henicocephalus cornifrons* Bergroth) which equals *Embolorrhinus* Jeannel, 1942, (type *Henicocephalus tuberculatus* Bergroth). In each of the above cases Jeannel's type was included in the list of species under my new genus.

Jeannel synonymizes *Aerochestes* Bergroth (type *Aenictopechys alluaudi* Jeannel) under Horvath's monotypic genus *Henschiella*. I had hesitated to do this because the unique character, "anterior coxal cavities closed," of Jeannel's species is not mentioned in Horvath's description and the type in the Museum at Budapest has not been re-examined to check this point. However, the two types agree in venation and other points so the synonymy is probably correct.

Perhaps the most outstanding contribution in Jeannel's work is his study of the genitalia of the Enicocephalidae. On the basis of his study of the male genitalia of the type of *Aenictopechys necopinatus* Breddin from the Museum of Hamburg, Jeannel has retained my subfamily Aenictophinae (spelled Aenictopechitae). He has also placed Enderlein's enigmatic *Phthirocoris antarcticus* which Bergroth assumed was based upon immature specimens. Jeannel's excellent illustrations of the male genitalia of the types from the Zoological Museum of the University of Berlin show that *Phthirocoris* is a unique genus of apterous Enicocephalidae based upon sexually mature but neoteinic specimens.

ARCHAEOPODAGRION BILOBATA, N. SP., FROM CENTRAL ECUADOR
(Odonata: Megapodagrioninae)

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This paper supplements Kennedy, 1939, "*Archaeopodagrion bicorne*, a very primitive dragonfly from Eastern Ecuador," Ann. Ent. Soc. Amer. 32: 32–43. The review of the pertinent literature attached to that paper will cover this article. *Bicorne* was given its own genus, *Archaeopodagrion*, because it showed characters which indicated relationships between two groups of genera of the South American Megapodagrioninae.

The present material is one male so rotten that it fell apart on opening the envelope; collected by Sr. Leopoldo Gómez Alonso recently in the U. S. Chinchona Survey. It was collected at Macas, Rio Upano, which stream is the headwater of the Rio Santiago in the military Province Santiago-Zamora of the "Oriente," the area of Ecuador east of the Andes. Gómez gives the elevation of Macas as 1050 meters. This area is south of Baños, east of which town on branches of the Rio Pastaza the genotype of *Archaeopodagrion bicorne* K. was taken. Both areas appear to be foot-hill streams in the extreme western end of the Amazon Basin.[1]

The name *bilobata* parallels *bicorne* and is in reference to the more deeply split posterior lobe of the prothorax (fig. 9) than in *bicorne*. The single specimen (♂) is at present in the author's collection.

Holotype male: Length,[2] abdomen, 35 mm.; hind wing, 25 mm.

Color. Fig. 10. Labrum medium blue, edged with black below, ante-clypeus pale (greenish yellow?) edged with black above which is continuous with the horizontal surface of the post-clypeus. Bases of jaws, lower three-fourths of genae pale greenish yellow. Frons, vertex, occiput (entire top of head and antennae) black; under surface of head entirely black. Labium (except palps black) and bases of maxillae pale. Maxillary palps black.

Eyes in the dried rotten specimen uniformly dark with perhaps a slight greenish tint.

Prothorax. Fig. 5. Anterior lobe black; middle and posterior lobes broadly black above; lower half of side of middle lobe pale, sharply defined from the black above, the pale area continued on the posterior lobe covering its lower half but not sharply defined from the black above. Coxa and trochanter pale except for a brown cross-line at apex of trochanter (fig. 3).

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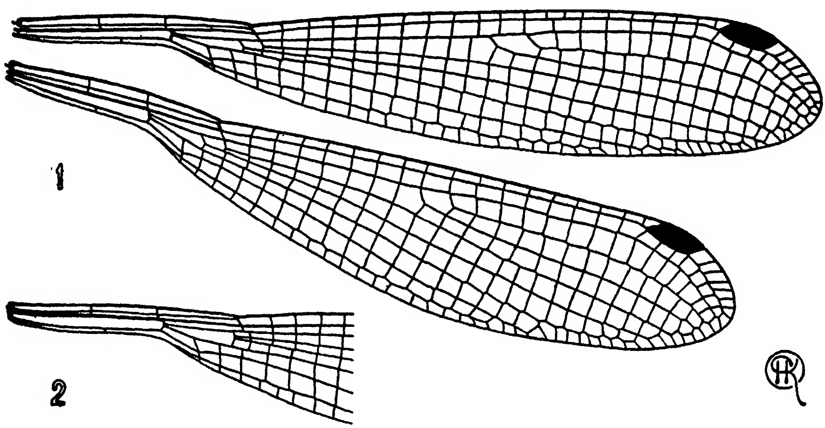
[1]Brown, F. Martin, 1941. "A Gazetteer of Entomological Stations in Ecuador." Ann. Ent. Soc. Amer. 34(4): 809–851, 10 maps.

[2]The measurements of *bicorne* K. are, male abd., 35 mm.; hind wing, 25 mm. female, abd., 31 mm.; hind wing, 27 mm. These were omitted in the origina description, 1939.

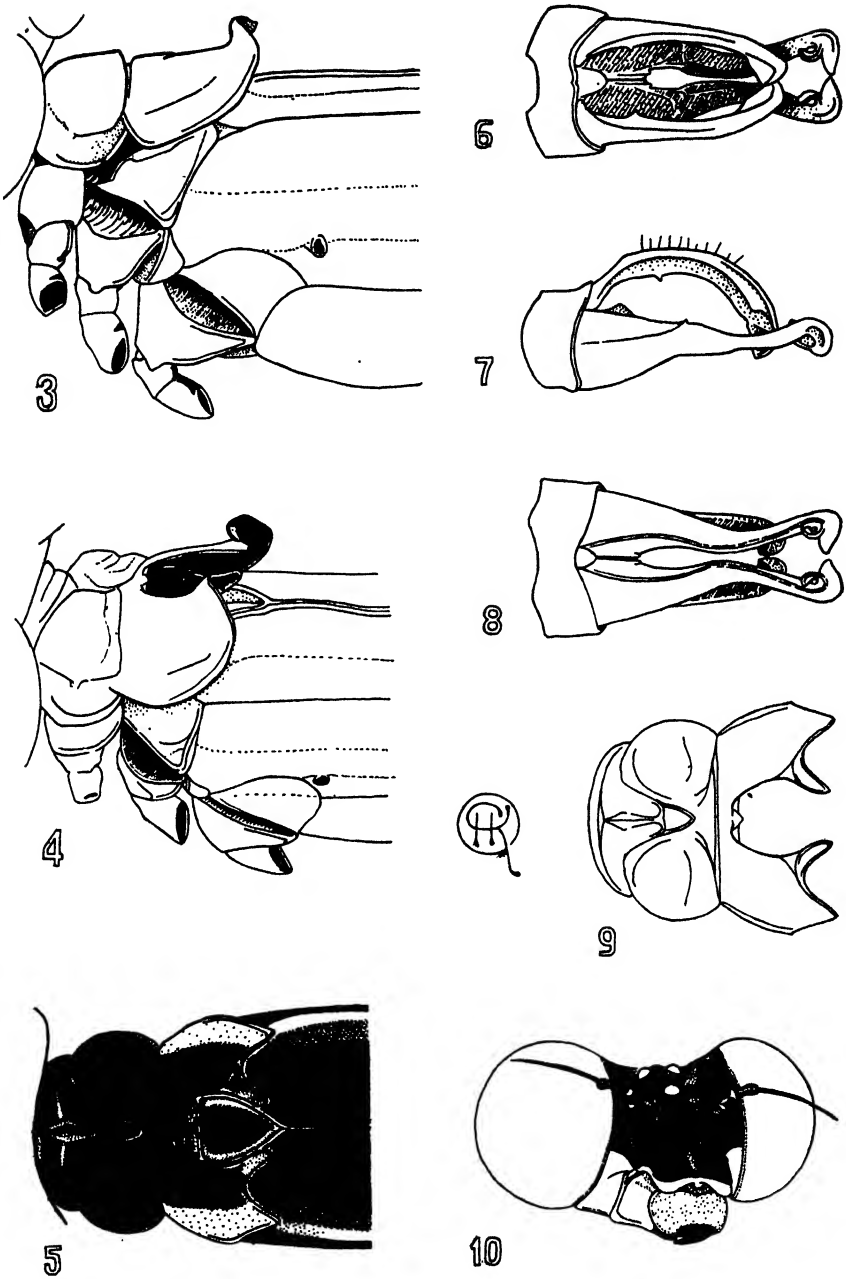
Pterothorax with mesostigmal lamina and antealar sinus black. The black continued down, covering the mesinfraepisternum except for its pale lower posterior corner. A broad black middorsal stripe covering the dorsal or inner halves of the mesepisterna. This stripe slightly narrowed before the antealar carinae, the triangular area of which is black. The black of the mesinfraepisternum continued caudad as a vague, dark area covering the mesepimeron (fig. 14). (The upper half along the humeral suture may be pale (blue?) in life.) A similar vague or slightly darker stripe covering the upper third and anterior edge of the metinfraepisternum and continued as a dark stripe covering the lower (below spiracle) two-fifths of the metepisternum. Side of thorax and coxae otherwise pale with a distinct pale bluish tinge shading into a creamy yellow on the inferior surface. Sternites, II and III, black. Coxae pale. Trochanters with an apical



FIGS. 1 and 2. *Archaeopodagrion bilobata* n. sp.
1. Left forewings reversed. 2. Base of right forewing showing abnormal origins of Rs and M_3.

dorsal black spot (fig. 3). Femora pale with a broad dorsal black stripe merging into a black "knee." Tibiae pale except extreme tip dark. Tarsi dark. All spines black. Wings with stigmas black and a very diffuse yellow, smoky tint from stigma to apex.

Abdomen with sides of seg. 1 pale (blue?); a narrow apical ring and dorsum black. Seg. 2 black: lower half of side pale (blue?), pale area occupying the middle three-fifths of the side, the pale extending to the inferior-posterior angle. Sternal parts of segs. 1 and 2 pale; the walls of the genital fossa and anterior hamules broadly edged with black. Penis shaft and seminal vesicle black. Segs. 3–7 black with a well-developed anterior pale ring divided on the dorsal line by black. The lower posterior angle of the anterior pale ring continued caudad in a slender triangular pale area one-third to one-fourth the length of the segment. Segs. 8–10 black with a suggestion of pale along the anterior

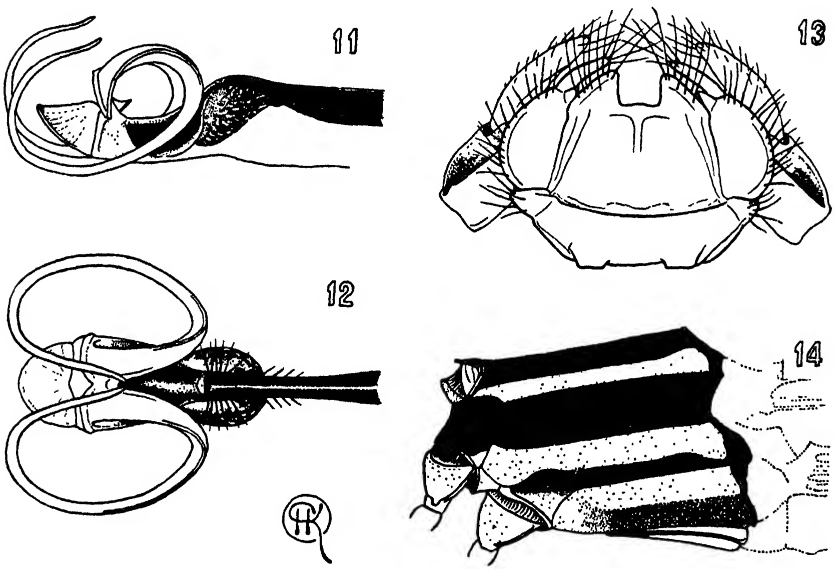


FIGS. 3-10. *Archaeopodagrion bilobata* n. sp.
3-5 and 9. Views of the bilobed prothorax. 6-8. Male appendages. 10. Face.

half of the lower edge of the side. Sterna of 3–10 black. Both superior and inferior appendages black. *Bilobata* is a distinctly darker colored species than *bicorne*, particularly in color of the abdomen.

Structure: Head.—Labium with a quadrangular apical notch as deep as that in *bicorne* (fig. 13). Frons broadly rounded between vertical and horizontal surfaces (no transverse frontal keel as in some Heteragrions). Fig. 10.

Prothorax.—(Compare with figs. 5–7 of *bicorne*, 1939.) Middle lobe with a sharply and deeply impressed dorsal area (figs. 4, 5, 9). Posterior lobe enormously developed into a divided apron either half



FIGS. 11–14. *Archaeopodagrion bilobata* n. sp.

11, 12. Penis. 13. Labium (and maxillae) showing the quadrangular apical notch as in Heteragrion.

14. Probable colors of pterothorax. (The pale humeral stripe may extend over upper half of mesepimeron, while its upper half may be infuscated as shown in fig. 5.)

of which spreads over a "shoulder" of the pterothorax. Viewed from above the posterior edge of each lobe has two angles, an outer angle over the humeral suture slightly less than 90°, an inner blade-like angle lying over the diagonal posterior rim of the mesostigmal lamina (fig. 5). Viewed from the side the base of the inner blade-like angle is the apex of one of the two horns projecting vertically. The outer angle of each half of the apron appears more rounded, the inner blade-like lobe is hidden behind its base except for perhaps its tip in some views (fig. 3).

Thus from its side the prothorax looks very much like that in ***bicorne***, but viewed from above the two horns disappear and the inner knife-like blade and the outer angle appear.

Pterothorax with a simple mesostigmal lamina as in ***bicornis;*** and of the general form and size of that in ***bicorne***. Legs similar to those in ***bicorne*** (1939, figs. 3 and 4).

Wings (fig. 1), length from base to nodus 3.5 times in total length. Greatest width in length, f. wg. 5.6 times, h. wg. 5.2 times; petioled to end of basal third of quadrangle. Stigma is long, subtending 2.5 R_1 cells, wider than in ***bicorne***, width 3 times in greatest diagonal length; ends distinctly oblique (45°); a light-weight brace vein. Antenodals 2; arculus distinctly beyond second antenodal in forewing, barely beyond second antenodal in hindwing. Post-nodals 20 in forewing, 17 in hindwing. M_2 arises halfway between p. n. 9 and 10 in forewing, at 8 in hindwing. M_{1a} arises just beyond postnodal 11 in forewing and at postnodal 9 in hindwing. Rs arises at subnodus in both wings; M_3 arises in both wings basad of subnodus the length of one middle costal cell. All veins smooth except tips of R_1 beyond stigma; M_1, M_{1a}, and outer halves of M_4 and Cu_2. In both wings 2 post-quadrangular M_4 cells, quadrangle long and narrow, widening distally, its outer side oblique. Forewing, the outer end of quadrangle 2.3 times in anterior side, 3.4 times in the posterior side; inner end 5.2 times in length of anterior side. Hindwing, quadrangle with outer side 3 times in anterior side, 3.5 times in posterior side; inner end 6.8 times into anterior side. Apex of Cu_2, f. wg., at level of end of fourth M_{1a} cell. Apex of Cu_2, h. wg., at a level of 3rd costal cell beyond origin of M_{1a}. No extra sectors other than M_{1a}. Anal crossing, forewing, at level of apex of basal third of distance between antenodal 1 and 2; at the level of end of basal fourth of distance between antenodal 1 and 2 in hindwing. Fig. 2 shows the abnormal origins of Rs and M_3 in the right forewing.

Abdomen moderately slender, depth of middle of seg. 4, slightly less than depth of seg. 10. The latter seg. twice as deep as long (fig. 7).

Penis, figs. 11, 12, with a distinct but small inner lobe (fig. 11) of the shape of that in *Megapodagrion*. The slender apical lobes are slightly more robust than in ***bicorne*** (1939, figs. 12, 13) and have the notch separating them (fig. 12), deeper than that in ***bicorne***, thus more like *Megapodagrion*. The erectile terminal flap is shown erected by a drop of hot water and is probably little different from that in ***bicorne*** (1939, figs. 12, 13), where it is dried. When fully moist the terminal lobes are round in cross-section and less ribbon-like. A single row of shaft spines.

Apical appendages long; superiors 3.6 times as long as seg. 10; inferiors 4.6 times as long as seg. 10. Dorsal view: superiors slightly curved ectad from base to apex, the two tips slightly overlapping; forcipate, apical 6th widening to a truncate tip, the inner edge of which widened portion is a knife edge; a small triangular spine on the inner profile at slightly more than one-fourth the distance from base to apex. Inferior appendages longer than superiors by one-fourth the length of the latter; the two fused from base to end of basal fourth of length, slender, approaching each other at their outer three-fifths, then widening

to apex which is turned entad at right angles to shaft of appendage and which ends in an acute point; at the inner base of this turned-in apex is a minute blade-like branch which curves back and up from the main tip. A minute dorsal spine or ridge on dorsal side of mid-length of interior not visible when viewed from above.

Side view: The superiors long, narrow, gently arched through 120° of circle; narrower at base than in outer two-thirds; a minute internal spine visible at end of basal third. Inferiors with base 3 times into length. A minute spine (end of a sharp cross ridge?) at apex of basal three-sevenths. Apices of inferior turned down in a smoothly rounded curve covering the apical half of the inner apical branch which curves up.

Remarks: The species *bilobata* fits exactly into the Genus *Archaeopodagrion* Kennedy as described for the species *bicorne*, 1939. We care to make no changes in generic characterization with the discovery of the second species. No other characters appear in the second species which would suggest that *Archaeopodagrion* is other than a very simply veined Megapodagrionine genus.

BRAZIL, ORCHID OF THE TROPICS, by MULFORD and RACINE FOSTER. xi+ 314 pp., many plates, both half-tone and colored. The Jacques Cattell Press, Lancaster, Pa., 1945. Price $3.00.

This interesting book is essentially a tale of travel and botanical exploration, with bromeliads as the major goal, but whether or not one knows a bromeliad from a cabbage he will find it good reading. It is replete with observations on the nature of the country, conditions of travel and the peculiar problems of collecting epiphytic plants. A lowly insect chaser does not envy the feats of climbing involved, nor the size and weight of the specimens secured, but as he reads he does wonder what that upper world of the jungle might contain for him.

Mr. and Mrs. Foster landed at Rio de Janeiro, worked north into Bahia where they collected along the Rio de Contas. The little coastal state of Espirito Santo is treated next, then Rio and São Paulo, followed by several chapters devoted to Parana. The remainder of the book treats a second trip taken in 1940, chiefly in São Paulo, Minas Geraes and Matto Grosso. Thus the area covered is the central coastal portion of the country and inland into Matto Grosso, certainly a representative section of this rich and varied land.

Many years ago the reviewer decided that his money would buy much more South American material from resident collectors than it would secure if expended on a collecting trip. He had not then read such an account of collecting on that fabulously rich continent! The Fosters present such a fascinating account of their experiences that they awaken again the desire to see insects on the wing which are now known only as dried specimens, to pry into the secrets of strange territory, to seek rarities where they live. They tempt their scientific readers while they entertain them. By all means read their book if you want either result, and if you are tempted to the point of doing as they did, the tale of their experiences will also prepare you for the conditions of such a trip. It must involve hard work and primitive living conditions for the best results, but it must also provide lasting memories which one must envy these fortunate botanists.

—A. W. L.

ON THE CHILOPODS OF ALASKA

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In this paper is summarized what is now known of the chilopods of Alaska. It is occasioned by the coming into my hands of the material collected at several points in the territory, more particularly in the Watanuska Valley, by Dr. Joseph C. Chamberlin during 1943, 1944, and 1945. This material has increased substantially our knowledge of the centiped fauna of the region. Of the twenty-two forms here listed twelve species are described as new, among these species being representatives of three new genera and one new subgenus. Types of new species as well as all other specimens are retained at present in the author's collection at the University of Utah.

LIST OF SPECIES

Escaryus albus Cook
Escaryus delus, new species
Escaryus paucipes, new species
Geophilus alaskanus Cook
Geophilus ethopus Chamberlin
Pachymerium ferrugineum (C. L. Koch)
Synthophilus boreus, new genus and species
Cheiletha alaska, new genus and species
Linotaenia chionophila (Wood)
Lamyctes fulvicornis (Meinert)
Oabius alaskanus, new species
Oabius adjacens, new species
Oabius arktaus, new species
Paobius boreus Chamberlin
Monotarsobius tricalcaratus Attems
Ezembius stejnegeri (Bollman)
Nadabius caducipes, new species
Alaskobius josephus, new genus and species
Alaskobius adlatus, new species
Alaskobius parvior, new species
Ethopolys integer alaskanua, Chamberlin
Bothropolys (*Oligopolys*) *ethus*, new subgenus and species

Order **GEOPHILIDA**

Family **Schendylidae**

Escaryus albus Cook

Escaryus albus Cook, Harriman Alaska Expedition, 1904, VIII, p. 77.

Known only from the types, two specimens taken on St. Paul Island in the Pribilof group in 1897 by T. Kincaid.

Escaryus delus, n. sp.

Dorsum yellow, of orange tinge at caudal end and more especially over anterior portion, the head a deeper orange.

The cephalic plate only slightly longer than broad anteriorly, narrowing conspicuously caudad. Frontal plate not discrete. (See fig. 1).

On the clypeus in front of the labrum two large non-areolate fields, separated by a narrow areolate median stripe. Across anterior border of clypeus a transverse series of twelve setae; farther caudad two setae on median areolate stripe.

Labrum at middle moderately embayed; the teeth about twenty-one in number, stout and of moderate length, not distally prolonged in slender tips as they are in *sibiricus*. See further fig. 2. Syncoxite of first maxillae without lappets; palpus biarticulate, with a long lappet, the terminal joint also prolonged into a membranous tip. Mandibles with teeth in three distinct blocks.

Basal plate overlapped anteriorly by the cephalic; as wide, posteriorly as the cephalic plate. (fig. 1). Prehensors large, well exposed in dorsal view; claws when closed not surpassing anterior margin of head; prosternum broad, without chitinous lines and unarmed anteriorly; joints of prehensors short, all unarmed.

Dorsal plates bisulcate.

First spiracles much larger than the second, circular.

Sternites with a shallow basin-like depression in middle region at the bottom of which is a longitudinal sulcus which does not reach anterior or posterior margins.

Ventral pores not detected.

Last ventral plate relatively long and narrow, somewhat narrower than the penult sternite is posteriorly; with its sides nearly parallel. Coxal pores small and numerous.

Anal pores present, small.

Anal legs of male conspicuously inflated, its thin claw distinctly developed, but small.

Pairs of legs in male holotype, 47; in female allotype, 45.

Length, 40 mm.

Locality.—Alaska: Circle City, June 21, 1945. One male taken by Drs. J. C. Chamberlin and Jeanne Johnson. Fairbanks: One female taken September 22, 1943.

This species may be placed with reference to the other species known from the Alaskan and Siberian regions by means of the following key:

KEY TO SPECIES OF ESCARYUS

1. Claw of anal legs very small in comparison with those of other legs............2
   Claw of anal legs of normal size, as large as those of other legs...**E. albus** Cook
2. Anal pores present (Alaska)...............................**E. delus** n. sp.
   Anal pores absent..3
3. Pairs of legs 33 (Alaska)...........................**E. paucipes** n. sp.
   Pairs of legs 49–51 (Asia)..4
4. Syncoxite of first maxillae with long membranous lappets; lateral teeth of labrum with long, slender tips...........................**sibiricus** Cook
   Syncoxite of first maxillae without membranous lappets, all teeth of labrum short, and stout...................................**japonicus** Attems

Escaryus paucipes, n. sp.

Cephalic plate of form shown in fig. 3. Antennae gently-attenuated distad.

Clypeus without non-areolate fields in front of the labrum. Labrum simple, not divided, the median arc with twelve stout teeth as shown in fig. 4.

Dental plate of mandible divided into three blocks of 3, 4, and 5, teeth respectively, the first (distal) tooth of each block much larger than the others. First maxillae without membranous lappets.

Basal plate covered anteriorly, short. Prosternum without chitinous lines. Claws of prehensors when closed not passing anterior margin of head; femuroid short, with a tooth at distal end; the second joint with a slight pale tubercle and the third with a more pronounced paler tooth; a dark tooth at base of the claw.

Spiracles all circular, the first much larger than the second, the second intermediate. Dorsal plate bisulcate, but the sulci not sharply defined.

Last ventral plate trapeziform. Coxal pores in holotype eight on each side, these all on lower surface.

Anal legs with claw considerably shorter than those of preceding legs.

No anal pores detected.

Pairs of legs, 33.

Length, about 14 mm.

Locality.—Alaska: Haines. One male taken August 23, 1945.

Readily distinguished among known species by the small number of legs, the lack of non-areolate clypeal areas and the structure of the labrum, etc.

Family **Geophilidae**

Geophilus alaskanus Cook

Geophilus alaskanus Cook, Harriman, Alaska. Expedition, VIII, 1904, p. 75.
Geophilus alaskanus Chamberlin, 1919, Canad. Arctic Exped., Vol. 3, p. 15H.

The male holotype was taken at Sitka in June, 1899, and it has also been taken on Forrester Island. (R. and H. Heath coll.)

Geophilus ethopus Chamberlin

Geophilus ethopus Chamberlin, 1920, Proc. Biol. Soc. Wash., Vol. 33, p. 43.

The male holotype was taken at Iditarod in June, 1918, by A. H. Twitchell.

Pachymerium ferrugineum (C. L. Koch)

Geophilus ferrugineus C. L. Koch, 1835, Deutschlands Crust, Myr. u. Arachniden, fasc 3, t. 2.
Pachymerium ferrugineum C. L. Koch, 1847, in Koch-Panzer, Krit. Revision d. Insekten-fauna Deutschlands, Vol. 3, p. 187.
Mecistocephalus attenuatus Cook (nec Say), 1904, Harriman Alaska Expedition, VIII, p. 74.

Recorded in the Harriman report from Yakutat Bay (a female with young) and from St. Paul Island. (One specimen taken by Kincaid in 1897.)

Genus **Synthophilus**, new

Cephalic plate but little longer than broad, typically lacking a frontal suture. Basal plate broad. Labrum with lateral divisions pectinate, the median more strongly dentate, with the free margins and their teeth directed ventrad. First maxillae lacking lappets. Coxae of second maxillae broadly joined at middle. Prehensors short lacking chitinous lines; each claw typically with a tooth toward base on inner side. Dorsal plates bisulcate. Ventral pores absent. Anal legs with tarsus biarticulate ending in a claw. Coxopleurae of last legs with several pores on ventral surface.

Generotype: *Synthophilus boreus*, new species.

Differing from *Brachygeophilus* in the ventrally directed teeth of the labrum and in lacking lappets from both joints of the first maxillae.

Synthophilus boreus, n. sp.

Cephalic plate only a little longer than broad (7 : 6), the caudal margin straight, the anterior margin very obtusely angular; without frontal suture (fig. 5). The clypeal region crossed by a fold presenting a sharply defined posterior margin from the convex middle portion of which several setae project caudad. Last article of antennae equal in length to the two preceding taken together.

The labrum with median division presenting about ten ventrally directed teeth, of which the two median are darker and more strongly sclerotized, overlapped on anterior side of each end by the lateral piece which is pectinate, with the pectinae also directed nearly ventrad. See further fig. 6. First maxillae with inner lobe bearing three setae in a longitudinal series; palpus biarticulate, the second article also bearing three ventral setae in longitudinal series. Second maxillae with coxae broadly united with median region membranous, less sclerotized; claw of palpus straight over basal and median region, curved only apically as shown in fig. 7.

Basal plate caudally as wide as the cephalic plate, comparatively long. Prebasal plate may be slightly exposed. (See fig. 1). Claws of prehensors each with a small tooth at base, the other articles unarmed; prosternum narrowly and deeply incised at middle; no chitinous lines.

Sternites with three sharply defined longitudinal sulci, a median and one on each side.

Last ventral plate broad, with the caudal margin straight. About six small coxal pores on each side.

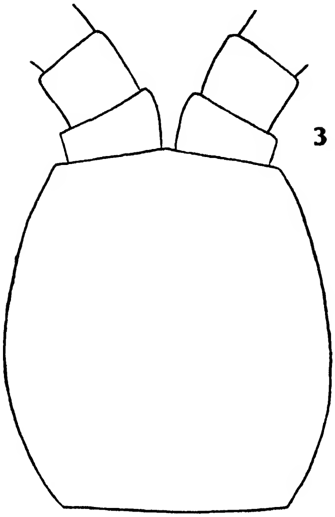
Length, about 21 mm.

Pairs of legs, 45–47.

Locality.—Alaska: Juneau, (Type Loc.), four specimens taken April 28–29, 1945; Haines, three specimens taken August 20–25, 1945, the types being taken August 22.

EXPLANATION OF PLATE I

Escaryus delus, new species. Fig. 1. Anterior end, dorsal view. Fig. 2. Labrum. *Escaryus paucipes*, new species. Fig. 3. Head, dorsal view. Fig. 4. Labrum. *Synthopihlus boreus*, new genus and species. Fig. 5. Head and basal plate, dorsal view.



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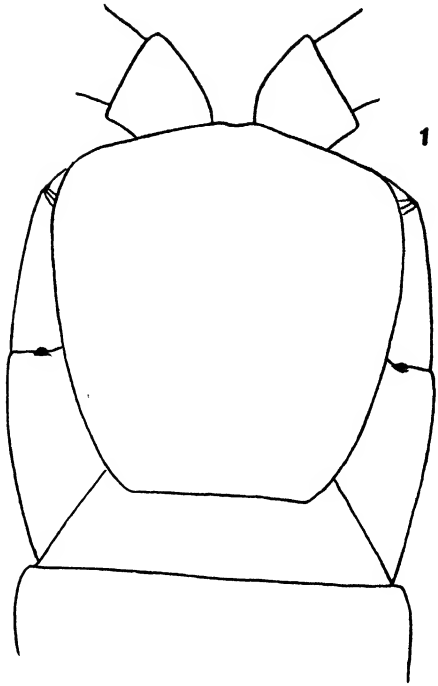

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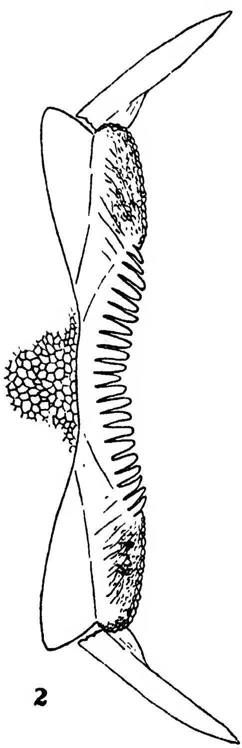

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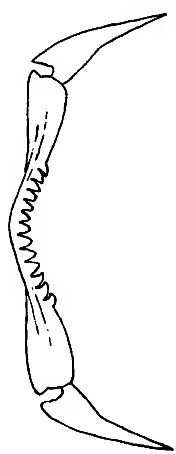

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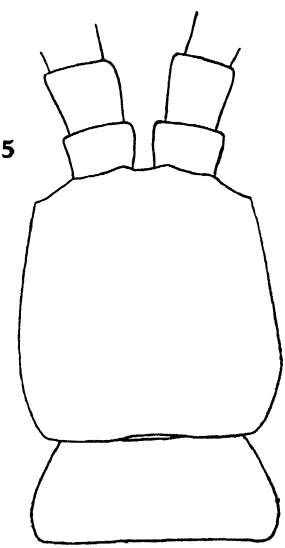

5

Family **Chilenophilidae**

Arctogeophilus glacialis Attems

Geophilus (*Arctogeophilus*) *glacialis* Attems, 1909, Ark. Zool., Vol. 5, nr. 3, p. 23, t 1, f. 1–4.
Cryophilus alaskanus Chamberlin, 1919, Rept. Can. Arctic Exped., Vol. III, p. 18H, figs. 1–5.

Locality.—College, near Fairbanks. One specimen taken by J. C. Chamberlin, June 26, 1945.

Previously recorded by Attems from Port Clarence and by Chamberlin from Nome.

Differences pointed out by the writer for *C. alaskanus* are apparently due to inaccuracies in Attems' original description and figures for *A. glacialis.*

Arctogeophilus melanonotus (Wood)

Mecistocephalus melanonotus Wood, 1862, Jour. Phila. Acad., Vol. V, p. 41.
Mecistocephalus limatus Wood, 1862, *ibid.*, p. 41.
Gnathomerium melanonotum, Chamberlin, 1911, Pomona College Jour. Ent. and Zool., Vol. 3, p. 661.

This species common in California and northward to British Columbia, off the coast of which it also occurs on Forrester Island, where it was collected by Ronald and Prof. H. Heath.

Genus **Chelietha,** new

A Chilenophelid genus apparently most closely related to the Australian *Queenslandophilus.* From the latter it differs in having the first maxillae with two pairs of membranous lappets instead of one, and in having the coxae of the second maxillae united only by a narrow, finely areolate isthmus instead of being fully separated.

Lateral pieces of labrum meeting at middle line in front of the median piece, fringed or toothed both at middle and laterally with long seta-like processes directed more or less caudad and typically not in a single series.

Prehensors large, toothed within, exposed from above both laterally and anteriorly.

Sternites lacking ventral pores. Last ventral plate of intermediate width. Coxal pores small and numerous. Anal legs with well developed claws.

Generotype: *Cheiletha alaska*, new species.

In addition to the genotype, includes *C. viridicans* (Attems), the latter occurring in Japan.

Cheiletha alaska, n. sp.

Cephalic plate much longer than broad (65 : 44); broadest a little in front of the middle, from where gently narrowing cephalad and conspicuously narrowing caudad, with caudal corners widely rounded. (fig. 8). Frontal suture indicated by a clear light line. A single, very finely areolate clypeal area. A transverse series of four setae each side of the clypeal area and two setae in line with its anterior margin. Last article of antennae about equal to the two preceding taken together.

Labrum with caudally, or in part ventrally, directed long setae at middle and inner part of sides, those at middle not in a single series; true teeth absent. (fig. 9). First maxillae each with two membranous lappets, one borne on coxal division and one on first joint of palpus. Coxae of second maxillae connected by a narrow, less sclerotized isthmus which is finely areolate.

Basal plate large, broader across base than the cephalic plate. Prebasal plate not exposed. Prehensors exposed in dorsal view, the claws when closed extending well beyond from margin of head, attaining or somewhat surpassing distal end of first antennal joint. Prosternum long, unarmed anteriorly, and without chitinous lines. Femuroid armed distally with a black, rounded tooth, the other two joints and the claw at base each armed with a smaller rounded tooth or nodule.

First spiracle large, a little vertically elongate or subelliptic, much exceeding the second in size.

Sternites without ventral pores. Anterior plates without anterior pits and posterior processes.

Last ventral plate moderately wide, only a little narrowed caudad. Coxal pores small and fairly numerous, arranged chiefly along the ventral and dorsal plates. Anal pores present, small.

Last legs with claw well developed.

Pairs of legs, 45–47.

Length, 25 mm.

Locality.—Alaska: Juneau. Eight specimens taken April 28–29, 1945, by J. C. Chamberlin.

Evidently very closely related to *C. viridicans* (Attems) of Japan but, according to Attems' description and figure, differing strikingly in having the labrum fringed with very long, seta-like teeth instead of being "am Rande *kraftig* und kurz gezähnte."

Family **Linotaeniidae**

Linotaenia chionophila (Wood)

Strigamia chionophila Wood, 1862, Jour. Phila. Acad. Sci., p. 50.
Scolioplanes chionophilus Meinert, 1885, Proc. Am. Phil. Soc., Vol. 21, p. 223.
Linotaenia chionophila Bollman, 1893, Bull. U. S. Nat. Mus., No. 46, p. 123; also Cook, 1898, The Fur and Fur-Seal Islands of the North Pacific Ocean, p. 4, p. 350.
Tomataenia chionophilia Cook, 1904, Harriman Alaska Exped., Vol. 8, p. 73.
Tomotaenia (Scolioplanes) chionophila Wood, Attems, Arkiv Zool., Vol. 5, p. 9.
Linotaenia chionophila Chamberlin, 1919, Canad. Arctic Exped., Vol. 8, p. 15H.

A species recorded from Sitka, Unalaska, Lowe Inlet, and on Pribilof, Aleutian, Kardiak, Boranof, Popof, Bering, Cooper, and Forrester Islands. The J. C. Chamberlin collection includes specimens from Juneau (April 28–29, 1945) and from Haines (August 25, 1945). It also ranges across Canada and the northern United States and is very close, at least, to the common European *L. acuminata* (Leach).

Order **LITHOBIIDA**

Family **Henicopidae**

Lamyctes fulvicornis Meinert

Lamyctes fulvicornis Meinert, 1842, Naturhistorisk Tidsskrift, 3rd ser., Vol. 5, p. 267.
Lamcytes fulvicornis Chamberlin 1912, Bull. Mus. Comp. Zool., Harvard University, Vol. 57, p 7.

About a dozen specimens of this species, widespread in Europe and North America, were taken by J. C. Chamberlin at Haines, August 25, 1945.

A single specimen was also taken at Fairbanks on September 22, 1943.

Oabius alaskanus, n. sp.

Yellow to pale chestnut, the antennae darker than the legs.

Antennae short. Ocelli in three series, the single ocellus not separated, moderately larger than the others; e. g., 1÷4, 4, 2.

Prosternal teeth 2÷2, with the median incision narrowly V-shaped and acute at the bottom.

Ventral spines of first legs, 0, 0, 1, 2, 1. Third joint of all legs dorsally armed. Ventral spines of penult legs, 0, 1, 3, 3, 1; dorsal, 1, 0, 3, 1, 0; claws 2. Ventral spines of anal legs, 0, 1, 3, 2, 0, or occasionally 0, 1, 3, 3, 0, on one side; dorsal spines, 1, 0, 3, 0, 0, claw single. Last coxae laterally armed, or rarely with no lateral spine.

Claw of female genital forceps tripartite; basal spines 2÷2, these proximally nearly parallel-sided, the outer one of each pair apically with two or three teeth or points.

Length, about 9 mm.

Locality.—Alaska: Haines. Thirteen specimens taken August 25, and numerous specimens August 23, 1945. Richardson Highway, 10 miles north of Rapids. One, June 16, 1945. Homer. About fifteen specimens taken July 28, 1945. Juneau. Twelve specimens taken April 28–29, 1945. Matanuska. One female, probably this species, taken May 7, 1945.

In the dorsal spining of the anal legs agreeing with *O. tabiphilus* Chamberlin, which occurs in California, but differing in having the dorsal spines of the penult legs 1, 0, 3, 1, 0, instead of 1, 0, 3, 1, 1, and in having no lateral spine on the penult coxae.

Oabius adjacens, n. sp.

A darker, more brownish form than *O. alaskanus* and also more robust.

Antennae short. Ocelli in three series, the single ocellus contiguous, somewhat smaller than the first one of the top row; e. g., 1÷4, 3, 3. Prosternal teeth 2÷2; the median incision V-shaped, less acute than in *O. alaskanus*.

Ventral spines of first legs 0, 0, 1, 3, 1. Ventral spines of penult legs, 0, 1, 3, 3, 1; dorsal, 1, 0, 3, 1, 1, claws 2. Ventral spines of anal legs, 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 0, 0; claw single. Last two pairs of coxae laterally armed.

EXPLANATION OF PLATE II

Synthophilus boreus, new species (cont.) Fig. 6. Labrum. Fig. 7. Tip of palpus of second maxilla. *Cheiletha alaska*, new genus and species. Fig. 8. Head, dorsal view. Fig. 9. Labrum. *Alaskobius josephus*, new genus and species. Fig. 10. Portion of anal leg, mesal view, showing form of process of fourth joint. *Alaskobius adlatus*, new species. Fig. 11. Portion of anal leg, mesal view, showing process of fourth joint.

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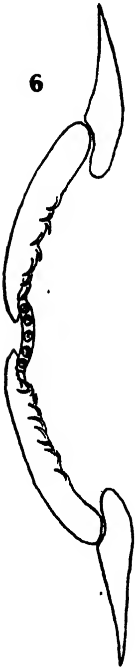

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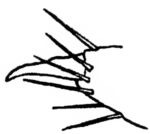

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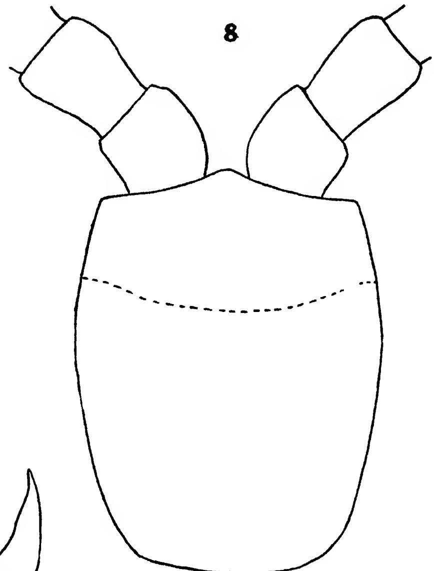

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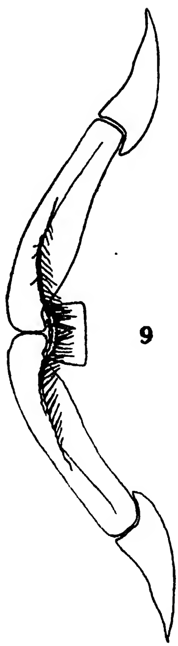

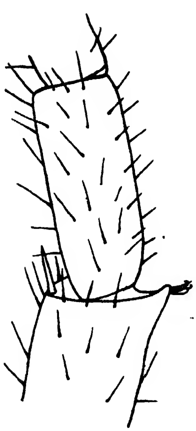

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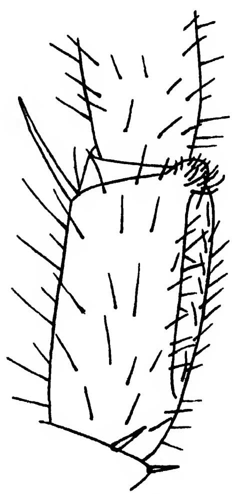

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Claw of female genital forceps tripartite; basal spines 2÷2, essentially as in *alaskanus*.

Length, about 9 mm.

Locality.—Alaska: Juneau. Seventeen specimens taken April 28–29, 1945.

This species is also close to *O. tabiphilus* with which it agrees in the spining of the anal legs and in having the last two pairs of coxae laterally armed. It differs, e. g., in having the fifth joint of legs following the first armed with a single dorsal spine instead of with two.

Oabius arktaus, n. sp.

A notably smaller species than the others herein listed.

Color yellow, with slight orange tinge, the pigment more dense in head and antennae.

Antennae short; articles short and very short. Ocelli few, 1÷2, 2, or 1÷2, 3.

Prosternal teeth small and pale, 2÷2.

Ventral spines of first legs, 0, 0, 0, 0, 1. Fifth joint of legs with a single dorsal spine. Ventral spines of penult legs, 0, 1, 3, 3, 2; dorsal, 1, 0, 3, 1, 0. Ventral spines of anal legs, 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 0, 0; claw single. Anal coxae laterally armed.

Claw of female gonopods tripartite. Basal spines 2÷2, proportionately long, cylindrical to the short, acuminate apical portion.

Length, 4–5 mm.

Locality.—Fairbanks. Two males and a female taken September 21–22, 1943.

Paobius boreus Chamberlin

Paobius boreus Chamberlin, 1916, Bull. Mus. Comp. Zool. Harvard. Vol. 57, No. 4, p. 163, pl. 3, figs. 7–9, pl. 4, figs. 1–3.

This species, the genotype of *Paobius*, was based upon numerous specimens taken on Forrester Island in 1913 by H. and R. W. Heath.

Monotarsobius tricalcaratus Attems

Monotarsobius tricalcaratus, Attems, 1909, Arkiv Zool., Vol. 5, No. 3, p. 20, pl. 1 fig. 5.

The female holotype of this form was taken by the Vega Expedition at Port Clarence.

Ezembius stejnegeri (Bollman)

Lithobius stejnegeri Bollman, 1893, Bull. U. S. Nat. Mus., Vol. 46, p. 129, Cook, 1904, Harriman Alaska. Exped., Vol. 8, p. 71.
Monotarsobius arcticus Attems, 1909, Arkiv Zool., Vol. 8, No. 3, p. 19.
Lithobius (Archilithobius) haasei Attems, 1909, *op. cit.*, p. 22.
Lithobius stejnegeri Chamberlin, 1911, Canad. Ent., p. 260.
Ezembius stejnegeri Chamberlin, 1919, Canad. Arctic Exped., Vol. 3, p. 19H.
Ezembius stejnegeri Chamberlin, 1923, North American Fauna, No. 46, U. S. Bureau of Biological Survey, p. 241.

Apparently common in the Alaska region. It has previously been recorded from St. Paul Island, St. George Island, Bering Island (type locality), Copper Island, Popof Island, and other neighboring islands.

It was also taken at Teller in 1913 by Johansen as recorded by the author in the report on the Canad. Arctic Exped. (P. 19H.)

In the J. C. Chamberlin collection there are specimens from Palmer (May 1, 1945), Butte Area in the Matnuska Valley (May 18, 1945), and Matanuska (May 7, 1945).

Nadabius caducipes, n. sp.

Pale orange yellow in general color; the antennae orange, posterior legs lighter orange, the other legs yellow.

Antennae very short, composed of the usual twenty articles. Ocelli in two series, e. g., 1÷3, 3; the single ocellus paler and much smaller than the first of the upper series, the middle ocellus of bottom series smaller than the others.

Prosternal teeth pale, 2÷2, the median incision shallow, acutely V-shaped.

No ventral spines on first legs, the dorsal spine 0, 0, 0, 0, 1. Ventral spines of penult legs 0, 1, 3, 3, (2), 1; dorsal spines 1, 0, 2, 1, 0; claw armed. Ventral spines of anal legs, 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 1, 0; claw armed. Dorsal spines of thirteenth legs, 1, 0, 2, 1, 1; of the twelfth, 0, 0, 1, 1, 1. None of the coxae laterally armed.

Process of fifth joint of anal legs of male of usual general form but low; located toward mesal edge. The penult legs of male also conspicuously modified, having on the fifth joint along dorsocaudal face a ridge or low hill running from near middle to distal end.

Claw of female genital forceps tripartite; basal spines 2÷2.

Length of male holotype, 9 mm.

Locality.—Alaska: Beluga Flats, 3—4 miles southwest of Beluga River on Cook Inlet. An adult male, the holotype, and several not fully developed females taken September 1-3, 1945. With the exception of the male, the specimens have lost their posterior legs.

Genus **Alaskobius,** new

Characterized in the male by having a dorsal lobe at end of fourth joint of anal legs, suggesting that present on the fifth joint in *Nadabius*. Antennae composed of twenty short articles. Ocelli seriate. Prosternal teeth 2÷2. Posterior angles of none of the dorsal plates produced. Anterior tarsi undivided.

Generotype: *Alaskaobius josephus*, n. sp.

Alaskobius josephus, n. sp.

A small form of a rufous yellow color. Antennae also rufous, but the legs paler and rufous.

Antennae very short. Ocelli on lower border of plate, in three oblique or two irregular longitudinal ones; e. g., 1÷3, 3, or 1÷2, 4.

Prosternal teeth pale, the median incision narrowly V-shaped.

Ventral spines of first legs 0, 0, 0, 0, 1, or 0, 0, 0, 1, 1; no dorsal spines. Second legs with or without a dorsal spine at distal end of fifth joint. Ventral spines of penult legs 0, 1, 3, 3, (2), 1; dorsal, 0, 0, 3, 1, 0; claw armed. Ventral spines of anal legs, 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 0, 0; accessory claw present. None of coxae laterally armed.

Genital forceps with claw tripartite. Basal spines proportionately short, 2÷2.

Lobe of fourth joint of anal legs of male as shown in fig. 10.

Length, 7.5 mm.

Locality.—Alaska: Matnauska. A female holotype and female allotype taken May 7, 1945. A male paratype taken in October, 1943. Circle City. A male and female, June 21, 1945. Matanuska Valley, Bodenburg Butte. One female, June 2, 1945, and numerous males and females taken August 23–31, 1943. Matanuska River at Hicks Creek. One female, September 17, 1945. Palmer. Four males and one female taken under stones, May 7, 1945, and a male and female taken October 16, 1943. Fairbanks. Many specimens taken September 21, 1943.

Alaskobius adlatus, n. sp.

Apparently a somewhat larger form than the preceding species. From the latter the male differs in having the dorsal lobe of the fourth joint of the anal legs smaller, with a wide longitudinal dorsal sulcus proximad of it. (see fig. 11). It also differs in having the ventral spines of these legs 0, 1, 3, 1, 0, instead of 0, 1, 3, 2, 0.

Length, about 9 mm.

Locality.—Alaska: Richardson Highway, 5 miles south of Rapids. One male.

Alaskobius parvior, n. sp.

Distinguished from the other two species in its much smaller size, fewer ocelli, etc.

Antennae very short. Ocelli 1÷2, the single ocellus small, the adjacent one largest.

Prosternal teeth 2÷2; the lateral margin of prosternum slanting directly back ectocaudad.

Ventral spines of anal legs 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 0, 0; claws 2. Ventral spines of penult legs, 0, 1, 3, 3, 1; dorsal, 1, 0, 2, 1, 0. None of coxae laterally armed.

Claw of female genital claws tripartite. Basal spines 2÷2, short, broad at base but acuminate from base or near middle; those of each pair equal or nearly so.

Length, about 4.5 mm.

Locality.—College, near Fairbanks. One female taken September 22, 1943.

In the absence of the male, there may be some doubt as to this species belonging in *Alaskobius*, but the reference is probably correct. If the male should not confirm this disposition, the form would fall into *Oabius*, subgenus *Nyctobius*.

Family **Ethopolidae**

Ethopolys integer alaskanus Chamberlin

Ethopolys integer alaskanus Chamberlin, 1919, Canad. Arctic Exped., p. 21H.

This form has been previously recorded by the author from Sitka and Forrester Island where it was collected by H. and R. W. Heath in 1913.

Bothropolys (Oligopolys) ethus, new subgenus and species

This species is placed in a new subgenus on the basis of the lack of produced corners on any of the dorsal plates, the other known North American species having either the ninth, eleventh and thirteenth (Poropolys) or the sixth, seventh, ninth, eleventh and thirteenth dorsal plates (Bothropolys, sens. str.) with their posterior angles produced.

Antennae short, composed of the usual 20 articles. Eyes narrowly elongate, with ocelli in two or three series; e. g., 1÷5, 4, 3, the single ocellus contiguous and not enlarged.

Prosternal teeth 5÷5 or 4÷4, the special seta spiniform but much more slender than the teeth.

Coxal pores in the holotype in two series, those of the anterior series much smaller than those of the posterior or major series.

Ventral spines of first legs, 0, 0, 2, 3, 2; dorsal, 0, 0, 3, 2, 1; of the second, 0, 0, 2, 3, 2 and 0, 0, 3, 2, 2 respective; dorsal, 1, 0, 3, 1, 1. Ventral spines of the penult legs, 1, 1, 3, 3, 2; dorsal 1, 0, 3, 1, 1; accessory claw present minute. Ventral spines of anal legs, 1, 1, 3, 3, 2, 1; dorsal, 1, 0, 3, 2, 1 (claw missing on the only leg present but probably single). Last two pairs of coxae armed laterally as well as dorsally. Last coxae with a ventral spine as well as a lateral and dorsal one. Fourteenth coxae armed dorsally and laterally, the thirteenth armed dorsally only.

Length of type, 14 mm.

Locality.—U. S. Creek on Steese Highway, 62 miles northeast of Fairbanks. Two males taken June 20, 1945. One male, not fully mature (length 9 mm.), taken September 22, 1943.

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THE FULGOROIDEA, OR LANTERNFLIES, OF TRINIDAD AND ADJACENT PARTS OF SOUTH AMERICA, by R. G. Fennah. Proceedings of the United States National Museum, Vol. 95, pages 411–520, plates 7–17, 1945.

According to the introductory statement "the fulgoroid fauna of the island is continental and has a close affinity to that of the Brazilian subregion, though being relatively impoverished." But if relatively impoverished, it seems still a rich fauna in view of the contents of the article, which is based chiefly on a collection made by the writer and that of the Imperial College of Tropical Agriculture. The article includes a large number of descriptions of new species and several of new genera. Keys are not provided.—A. W. L.

THE STANDARDS BY WHICH THE SPOTLESS PHASE OF HIPPODAMIA CONVERGENS IS JUDGED[1]

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Ann Arbor, Michigan

It has been suggested by a specialist in the Coleoptera that the sizes of spots used in my ratings of the pattern of *Hippodamia convergens* (Coccinellidae) (Shull, 1944) should be put on record in order that others may more effectively distinguish the spotless phase in their collections. Students of this species will know, and others will easily understand, that the so-called "spotless" beetles often have spots. They could hardly have expected, until genetic work was done on the contrasted patterns, that spotless beetles (possessors of the dominant spotless gene) of certain lines of descent could as closely resemble the spotted ones as they were found to do.

In the experiments demonstrating this variability of the genetically spotless pattern it was necessary to use standard sizes of spots so that patterns could be expressed numerically. The scheme adopted was an arbitrary one, since the spots in a given position in different individuals form a finely graduated series. The largest size attained in each position was ascertained by examination of numerous spotted beetles in the strain used in the experiments. The diameters, or long axes, of these spots were then divided by four, and ideal spots created which had dimensions one-fourth, one-half, and three-fourths of the maximum dimensions. These spots are approximately shown in figure 1. Spots begin with a faint cloudiness; from that condition up to a dimension one-fourth of the maximum they were recorded as of size No. 1. From the one-fourth dimension to the one-half, the spots were rated as No. 2. From one-half to three-fourths was No. 3; from three-fourths to the maximum, No. 4.

In general, the size of the spots was estimated; to have measured them would have entailed prohibitive labor. Yet measurements were made at intervals to keep the standards fresh in mind. Allowance was made for differences in size of the beetles, and measurements of the elytra were made at intervals, particularly in large or small individuals, and in relation to measured spots of such individuals, to help maintain the standards. Some mistakes were of course made, as was demonstrated by rating the same beetles a second or third time after the earlier estimates were forgotten. But the errors were never more than 1, and the changes in subsequent estimates were about as often upward as downward. In a collection, therefore, the mean estimated size of the spots in a given position should be fairly accurate despite individual mistakes.

Occasionally a spot would be so lightly pigmented (sometimes a mere cloud) that it was placed in a class lower than that to which its

[1]Contribution from the Department of Zoology, University of Michigan. Aided by a gift from Mrs. S. Ralph Lazrus.

size entitled it. This was an attempt to make the amount of pigment the basis of classification, but no method was found of making the rank objective. Whether it was justifiable to make amount of pigment the basis, rather than the area covered, is not known.

Though all the spots fluctuate in size, the posterior three (arbitrarily numbered 4, 5 and 6) are the most useful in recognizing the spotless phase. Partly this is a consequence of their larger size. Partly it comes from their greater tendency to be absent; more spotless beetles lack their posterior spots completely than lack the three anterior ones completely. The scheme adopted for distinguishing the two patterns was therefore based on the three posterior spots only.

In some lines of descent there was no difficulty in recognizing the spotless individuals. In other lines, modifying genes reduced or nullified some of the inhibitory action of the spotless gene, and spots were enabled to develop. Where many of these modifiers existed in the same individual, the spots of a "spotless" beetle could be so large that the

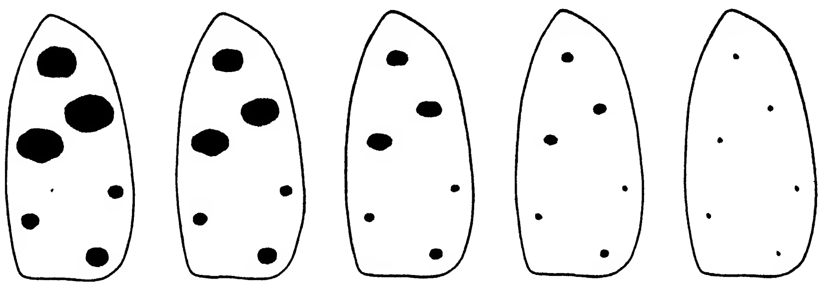

FIG. 1. Sizes of spots in *Hippodamia convergens*. Spots between 1 and 2 were rated 1, those between 2 and 3 were rated 2, etc. Minimal spots in first illustration could be mere cloudiness, not easily shown in ink drawings. Difficulties in engraving also prevent showing minimum size as small as it should be.

pattern would be regarded as spotted. This confusion existed only in certain pedigrees, and in these pedigrees the two patterns could be distinguished, in the overlapping group, only in a statistical sense. The combined rating of the three posterior spots of a spotted pattern could be at most $3 \times 4 = 12$. In the progeny of one pair of parents, it was determined that if the combined ratings of these three spots was more than 7.75 the beetle should be regarded as spotted, but if the combined ratings were less than that amount if should be considered spotless. This procedure should result in the proper proportion of the beetles having and lacking the spotless gene, but it would undoubtedly produce wrong judgments concerning some individuals.

Taxonomists should recognize the inadequacy of the system. The criterion proposed above was satisfactory for the group of beetles from which it was derived. In this group there were about four pairs of genes modifying the expression of spotless. These beetles were in Michigan. So far as has yet been determined, there are fewer than four pairs of modifiers in California. Presumably there are areas in

which more than four pairs exist. Whether the dividing value of 7.75 for the posterior spots would be valid in such areas cannot be known in advance of genetic work done on their populations.

Caution is also to be recommended against assuming that spots are suppressed only by the spotless gene. There are plain indications that in Colorado there are beetles of this species which would be called spotless according to the scheme proposed but which do not possess the gene for spotless. Too little genetic work has been done on the Colorado populations to indicate the system which prevails there.

A criterion of spotlessness, to be useful in the labeling of museum specimens, should be foolproof. It should be correctly applicable to individuals. A criterion which is valid only in a statistical sense is still useful in the highly important matter of geographic distinctions. The frequency of given alternative genes in a population is very significant in relation to evolutionary capacities. A population in which seven per cent of the pertinent chromosomes contain gene *S* is in a very different situation, with respect to future evolution, from one in which only two per cent of the chromosomes contain that gene. Geographic races depend on different distributions of certain genes. If smaller differences between gene frequencies can be demonstrated, the principles involved in geographic distribution can be applied to, and studied in, many new situations.

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ENTOMOLOGICAL NOMENCLATURE AND LITERATURE, by W. J. CHAMBERLIN. 135 pages, lithoprinted. Published by Edwards Brothers, Inc., Ann Arbor, Michigan, 1946.

The preface indicates that this volume was prepared for the use of students. For them it should be both helpful and stimulating, for it contains much practical information and some very interesting summaries of the lives and work of early scientists.

The author's advice to students on such problems as the nature of species and procedures in describing and naming them is clear and judicious. In such matters as the construction of keys he presents illustrations of the various patterns in use with a very clear analysis of their weaknesses and of the limitations under which they may be used. The summary of the International Rules and discussion of some of the problems of nomenclature also display excellent judgment and a laudably dispassionate treatment.

An abridged bibliography of this tremendous field could not fail to be subject to criticism if one cared to take up specific divisions. The writer has presented a selection of titles admirably comprehensive which should orient the student very satisfactorily and should prepare him to fill for himself the gaps that may be significant in his own work.

The volume concludes with directions for the preparation of manuscripts and other details of the process of publication. These directions are clear-cut and concise, and the remarks on the preparation of articles include some wise suggestions.

If Doctor Chamberlin's students follow his guidance they should make some valuable contributions to entomological learning.—A. W. L.

THE STRUCTURE OF THE GONADS OF THE WOOD-EATING BEETLE, PASSALUS CORNUTUS FABRICIUS

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This is the first part of a study on the development of the gonads of the wood-eating beetle, *Passalus cornutus* Fabricius, from their earliest appearance in the embryo to the definitive condition in the adult. Inasmuch as an intimate knowledge of the adult gonads is essential to an understanding of the development of these organs, the general morphology of the adult gonads will be discussed before their developmental history is traced.

STRUCTURE OF THE GONADS

In a consideration of the male genital system of the Coleoptera, Escherich (1894) concluded that the same fundamental plan predominates throughout the whole group. He used *Carabus* as an example of the most simplified type, and *Hydrophilus* as the more complex type, with *Blaps* as a somewhat intermediate form.

In *Carabus* the testis consisted of a simple, blind tube which twisted about and formed a coiled mass. The shape was ovoidal and somewhat tapering at the tip, and the whole convoluted region was enveloped by a fine tunic.

The testis of *Blaps* was nodule shaped and composed of two fascicles of short, radially arranged blind tubes. From each of the latter led a fine efferent duct, which united with the others to form a vas deferens. The peripheral end of each tube contained the sperm-forming cells, while the central part was filled with mature spermatozoa.

The third, still more complex type of testis, represented by that of *Hydrophilus*, was elongate and somewhat broad at the distal end, while narrowing at the proximal portion. It was composed of a very great number of fine, blind tubes about 1 mm. long, which were arranged radially with their long axes continuing proximally as efferent ducts.

Bordas (1900), with regard to the types of testes, divided the Coleoptera into two main groups; (1) those with simple, tubular testes, and (2) those with complex testes.

In the first group with simple, tubular testes belonged the Carabidae, Cicindelidae, Dytiscidae, etc., whose whole male genital system exhibited a primitive condition. The testes were composed of two cylindrical, more or less winding, coiled tubes. An enlarged region near the base served as a seminal vesicle. Histologically, the testes consisted of a very delicate external sheath and the genital cells.

The beetles with complex testes Bordas further divided into: (a) those with fascicular testes, and (b) those with cluster, or grape-like testes.

Those with testes composed of fascicles, that is, with the testicular follicles leading into the open end of the efferent duct, included the Aphodinae, Melolonthinae, Lucanidae, Chrysomelidae (except several genera), Curculionidae, Cerambycidae, etc. In all these the paired

testes consisted of 2–12 lobes of various sizes. These were spherical, ovoidal, or discoidal in shape, and each was divided into 50–100 truncate sections which led directly into a central reservoir by short efferent canals and then to the vas deferens.

To the group with testes composed of bunches of grapelike follicles belong the Tenebrionidae, Staphylinidae, Hydrophilidae, Silphidae, Coccinellidae, Elateridae, etc. The testes were made up of numerous club-shaped, cylindrical follicles which led directly into the central reservoir (Hydrophilidae, Staphylinidae), or into one of several lateral reservoirs.

In discussing the general morphology of the female reproductive organs, Snodgrass (1935) described a typical ovariole as consisting of three parts: a terminal filament, an egg tube, and a pedicel.

The slender, thread-like terminal filament at the distal part of the ovariole was a solid strand of cells enveloped by the tunica propria.

The egg tube was divided into the germarium, where the germ cells were in an active state of division and incipient differentiation, and the vitellarium, where the egg cells grew and attained their mature size. Beyond the last egg chamber a mass of follicle cells formed a "plug" which closed the proximal portion of the egg tube.

The pedicel, or stalk, was a short duct that connected the egg tube with the lateral oviduct.

Snodgrass stated that the ovariole is usually covered by "a thin structureless membrane known as the tunica propria." An "epithelial sheath" of flat cells is found outside the tunica in some insects. Imms (1938) and Comstock (1940) stated that muscle fibers were occasionally incorporated into this outer sheath.

Morison (1928) dealing with the various muscles of the honeybee, declared that all the muscles of the body showed striations. However, in a consideration of the muscles of the "reproductive organs" of the female, he inferred that muscles were lacking around the ovarioles for no mention was made of them at all.

In describing the various types of egg tube, Snodgrass used the generally accepted classification of Berlese, which divides them into panoistic, polytrophic, and acrotrophic types.

In the panoistic type there are no special nutritive cells differentiated from the egg cells. This type occurs in the Apterygota, Ephemerida, Odonata, Orthoptera, and Siphonaptera.

The Polytrophic type contains an alternating succession of oocytes and trophocytes, and is characteristic of the Anoplura, Neuroptera, Coleoptera-Adephaga, Lepidoptera, Hymenoptera, and Diptera.

A few insects, the Hemiptera and Coleoptera-Polyphaga, possess the acrotrophic type of egg tube. Here the oogonia give rise to nurse cells and oocytes. The former remain in the upper part of the egg tube, while the oocytes separate from them as the series of egg cells increases in the vitellarium. However, the original protoplasmic connections between the two sets of cells continue as long plasmatic strands. By means of these strands the oocytes in the egg tube continue to receive the yolk-forming material from the nurse cells. Consequently, the germarium in the acrotrophic type of ovariole could be looked upon as an apical feeding chamber for the oocytes.

OBSERVATIONS

The gonads of the adult male *Passalus* consist of two pairs of testes, one pair on each side of the body in the region of the third and fourth abdominal segments (fig. 1). Each of the four testes (*t*) is a slightly elongate cylindrical, bulb-shaped gland with a small nipple-like protuberance (*pt.*) at the extreme distal end. A narrow, eccentrically located duct leads from the testis to the seminal vesicle (*s. v.*) and vas deferens (*v. d.*). The duct from the other member of the pair also joins the same seminal vesicle. The efferent ducts from each side of the body unite in the midline and continue posteriorly as the single median ejaculatory duct (*ej. dt.*).

In the region of junction of the two vasa deferentia there are four elongate, blind tubular accessory glands (*ac. gl.*). The median pair are thick, winding, almost transparent glands, whereas the lateral ones are longer, more slender, more coiled, and quite opaque.

Around each individual testis is a peritoneal sheath (fig. 2). This investing coat is composed of a single sheet of cells and is bounded on each side by two very thin noncellular layers (*a* and *b*). The cell membranes of the epithelial sheath are not distinctly visible with the stains used. In many places small tracheae and tracheoles can be seen penetrating this outer peritoneal sheath.

Over the nipple-like protuberance the peritoneal sheath appears more complex (fig. 3). Here the continuations of the non-cellular layers (*a* and *b*) are much thicker, and the inner one (*b*) is divided into several sub-layers. From both of these layers many fine branches (*e*) can be seen extending into the cellular portion of the sheath and forming a reticular network of fine strands which are continuous with the non-cellular layers. Furthermore, the cellular part of the sheath is several cells thick, rather than a single layer as found in the proximal region of the testis (fig. 2). Although definite cell membranes are very difficult to make out even here, it is quite certain that the non-cellular strands (fig. 3, *e*) extend between adjacent cells. At the extreme tip of this region the inner layer (*b*) envelops a very small mass of cells (*d*) which are completely isolated from the remaining elements of the testis. The significance of this mass could not be determined.

Dividing the basal part of the testis into 20 to 25 or so wedge-shaped sections (figs. 4 and 5), the longitudinally arranged testicular septa extend from the proximal base of the testis nearly to the nipple-like part at the distal end. Each septum is composed of a thin cellular membrane with scattered elongate nuclei. At the peripheral region of the gland each testicular septum is joined to the adjacent one by a continuation of the membrane (figs. 2 and 4), (*c*) immediately beneath the enveloping peritoneal sheath.

Lengthwise through the center of the testis there extends a long, funnel-shaped sperm duct (figs. 4 and 6, *sp. dt.*). The funnel portion lies immediately proximal to the nipple-like protuberance at the distal end, and over the open entrance to the duct a dense irregular mass of cells arches in a somewhat dome-like fashion (fig. 6, *ep. ar.*). The sperm duct itself (fig. 8) is made up of tall columnar epithelial cells lying on a basement membrane with an irregular network underneath.

This duct leads out of the testis slightly eccentrically and enters the vas deferens via the seminal vesicle (fig. 1).

In the proximal portion of the young adult testis most of the cells are in some early phase of meiosis (fig. 9). This is indicated by the fact that the cut chromatin threads near the edge of the nucleus exhibit a paired or double condition, while there is little chromatin material toward the central region. These are probably in a meiotic phase just preceding the synapsis or pairing of the chromatin threads. Some other cells appear in slightly different phases of early meiosis.

In an older newly metamorphosed adult cysts of cells are undergoing the process of transformation into mature spermatozoa. These cysts are not restricted to any one definite region of the testis, but can be found both near the basal portion and farther distally.

Near the middle of the nipple-like protuberance many cells are being enveloped in cyst capsules. The chromatin material of these cells (fig. 10) is not limited to the peripheral region of the nucleus, as is the case in the preceding stage mentioned above. Here the chromatin tends to be densely packed near the center, although there is some distributed around the periphery and the chromatin threads do not exhibit a paired condition. Some other cells in the apical portion of the protuberance are slightly larger and are not yet enclosed in cyst capsules, but both types are evidently spermatogonia. Throughout the whole region of the protuberance mitotic figures are commonly visible.

In the sexually mature adult the basal part of the testis contains mostly the nearly complete spermatozoa. These are practically all located in the central region, lying near the sperm duct. Those near and in the funnel-like opening of the sperm duct under the epithelial arch seem to have been whirled around in such a way that these little balls of sperm are wrapped in their own tails. Toward the peripheral portion of the adult testis, surrounding the nearly mature spermatozoa, there are cysts of spermatids that have not yet undergone the process of transformation.

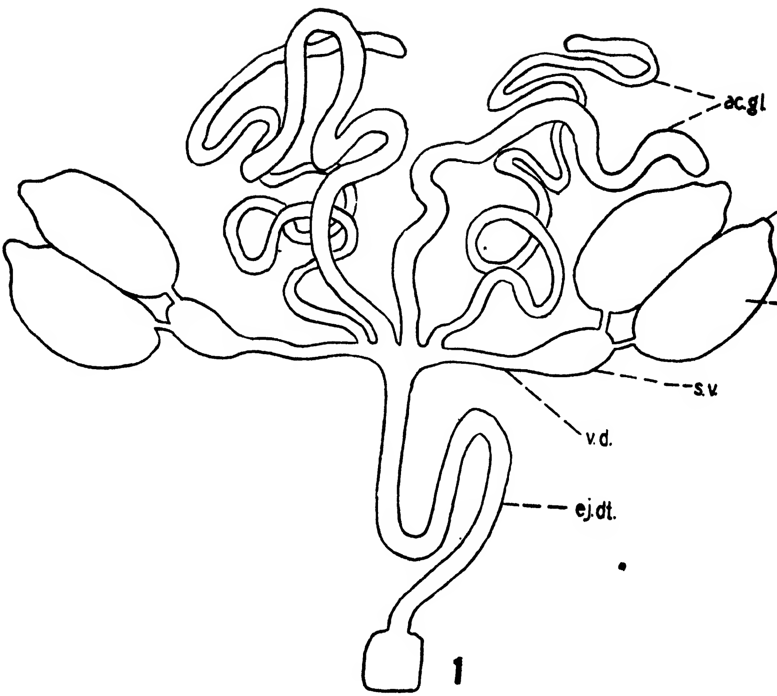
Like the male gonads, the female sex glands are also paired structures (fig. 12). The ovary on each side of the body is composed of two elongate, tapering, banana shaped ovarioles (*ov*) which join each other at their bases and connect with the lateral voiduct (*lt. ovd.*). The right and left lateral oviducts converge in the midline and continue posteriorly as the looped common oviduct (*cm. ovd.*). The latter duct connects with the vagina and bursa copulatrix (*b. cop.*). A prominent spermatheca and spermathecal gland lead into the bursa copulatrix.

EXPLANATION OF PLATE I

FIG. 1. Diagram of the male gonads and associated structures. *ac. gl.*—accessory gland; *ej. dt.*—ejaculatory duct; *pt.*—protuberance; *s. v.*—seminal vesicle; *t.*—testis; *v. d.*—vas deferens.

FIG. 2. Transverse section through the peritoneal sheath and part of a testicular septum of the testis. *a*—outer non-cellular layer; *b*—inner non-cellular layer; *c*—continuation of testicular septum; *p. s. n.*—nucleus of peritoneal sheath; *t. spt.*—testicular septum. ×825.

FIG. 3. Diagrammatic longitudinal section through the nipple-like protuberance of the testis. *a*—outer non-cellular layer; *b*—inner non-cellular layer; *d*—mass of enclosed cells at apex; *e*—branch of non-cellular network.



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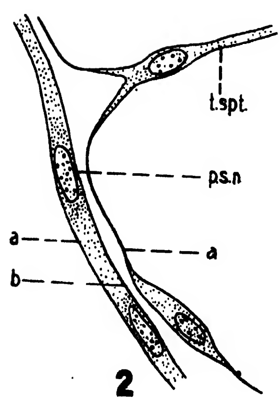

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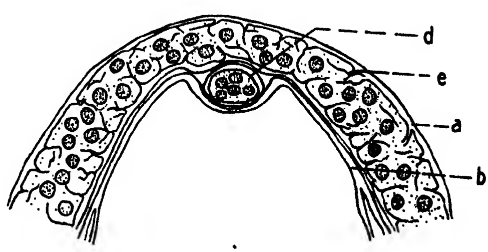

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Each ovariole is surrounded by a complex enveloping peritoneal sheath (fig. 11). Part of the sheath is made up of an inner circular layer (*c. mus.*) and an outer longitudinal (*l. mus.*) layer of muscles. These muscles are individual, spindle-shaped fibers that do not anastomose or branch, and they do not exhibit definite transverse or longitudinal striations, but appear to be like smooth muscles. The nuclei of these muscle fibers are usually located near the center, or slightly to one side of the center of the fiber. Outside the longitudinal layer, lying next to the hemocoel, there is a very thin cellular membrane (*a*), a typical mesothelium whose nuclei are very small and quite elongate.

As in the peritoneal sheath of the testis, many small tracheae and tracheoles can be seen penetrating the peritoneal sheath of the ovariole.

Immediately under this outer peritoneal sheath a thin, transparent, non-cellular sheath—the tunica propria (*t. p.*)—is found next to the cells of the ovariole.

At the extreme distal tip of the elongate ovariole is the terminal filament (fig. 13, *ter. fil.*) where the outer peritoneal sheath tapers to a fine thread-like structure.

Proximal to the terminal filament is the long germarium region (fig. 13, *germ*). Here the cells are packed tightly, have spherical nuclei, and appear to be all alike. The spiral-like tip of the germarium has relatively few nuclei and great amounts of brightly staining material (especially with Orange G and eosin). Even though a careful and detailed analysis of this material was not made, because of its apical position and characteristic staining, it seems quite likely that this region corresponds to the typical feeding chamber of the acrotrophic type of egg tube.

Between many of the cells of the ovariole in the central region there are large bright staining globules. However, no definite and continuous strands could be found connecting these with the spiral tip of the germarium.

In the region of the vitellarium (fig. 13, *vit*) several cells can be seen which have enlarged spherical nuclei and great amounts of cytoplasm (*ov*). There are transitional stages between those with smaller amounts of yolk material and as yet no follicle cells (fig. 14), and those with great amounts of yolk material and enclosed by a single, well-defined layer of follicle cells. Some of the medium sized cells show traces of plasmatic strands extending distally toward the germarium (figs. 13 and 16).

EXPLANATION OF PLATE II

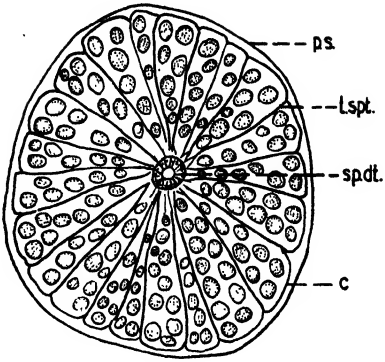
FIG. 4. Diagrammatic transverse section through the testis in the region of the sperm duct. *c*—continuation of testicular septum; *p. s.*—peritoneal sheath; *sp. dt.*—sperm duct; *t. spt.*—testicular septum.

FIG. 5. Diagrammatic longitudinal section of the testis to one side of the center. *sp. cy.*—sperm cyst; *t. spt.*—testicular septum.

FIG. 6. Diagrammatic longitudinal section through the center of the testis. b—mass of enclosed cells at apex; *ep. ar.*—epithelial arch; *pt*—nipple-like protuberance; *sp. cy.*—sperm cyst; *sp. dt.*—sperm duct.

FIG. 7. Diagram showing the path of sperm migration through the testis. *ep. ar.*—epithelial arch; *pt.*—protuberance; *sp. dt.*—sperm duct.

(See discussion for explanation of numbers.)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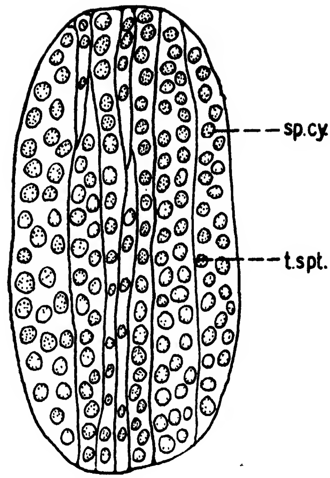
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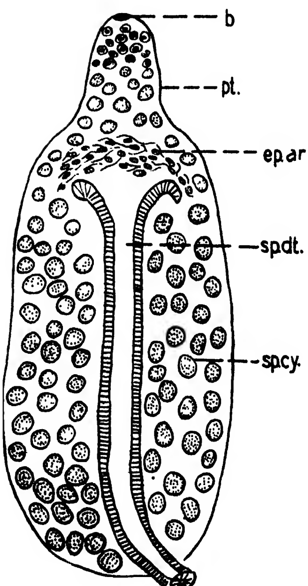
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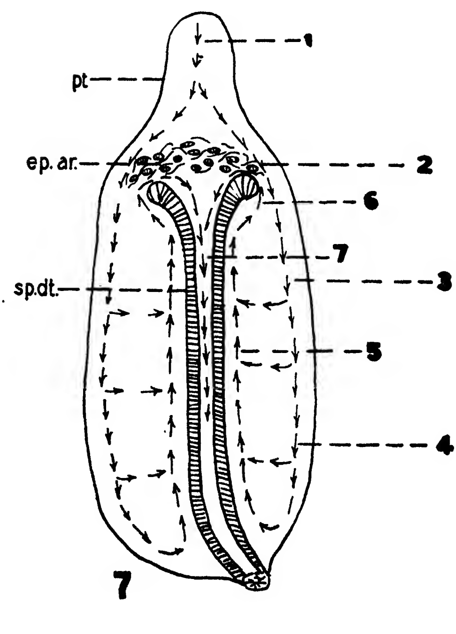
pt
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In the upper vitellarium there are many cells with slightly enlarged pale nuclei (fig. 15, *b*). Some of these have the cytoplasm arranged in a somewhat star- or amoeba-shaped form. It seems plausible that these blunt projections are the precursors of the relatively longer plasmatic strands of the enlarging oocytes (fig. 16).

Beyond the last and largest egg in the vitellarium is the epithelial plug (fig. 13, *ep. pl.*). An enlarged view of this area (fig. 17) reveals that it is a dense, somewhat irregular mass of follicle cells. In some regions of the plug, the follicle cells are very thin and elongate. This is at least partially due to the lateral stretching of the ovariole as a result of the tremendous increase in size of the developing ova. At the basal portion is the pedicel (fig. 13, *pd*), or stalk, by which the ovariole is attached to the lateral oviduct.

DISCUSSION

STRUCTURE OF THE MALE GONADS

Although the paired condition of the male gonads in *Passalus* is quite typical of many coleopteran testes, there are several other features which are rather unique.

According to the classifications of Bordas (1900) and Escherich (1894) the coleopteran testis is either a simple blind tube or a number of blind club-shaped follicles leading into the vas deferens via the vasa efferentia.

But in *Passalus* the testis is not a blind tube, nor is it divided into club-shaped follicles. Instead, there are 20–30 longitudinal testicular septa extending almost the whole length of the testis from distal to proximal regions, and radiating, like spokes of a wheel, from the centrally located sperm duct (figs. 4 and 6).

Similarly, the central sperm duct is somewhat atypical. This long, funnel-shaped canal extends from just below the nipple-like protuberance to the base of the testis and into the seminal vesicle. There are no efferent ducts entering the sperm duct along its course, and the only entrance to the canal is at the anterior, distal portion where the funnel-like mouth flares out (fig. 6).

Over this flared out opening to the sperm duct the mass of epithelial cells arches like a dome or roof. The significance of this epithelial arch will be discussed presently.

EXPLANATION OF PLATE III

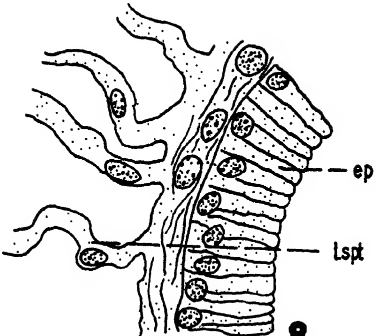
FIG. 8. Transverse section through the sperm duct of the testis. *ep.*—epithelial cell; *t. spt.*—testicular septum. × 825.

FIG. 9. Group of cells from sperm cyst in basal portion of newly metamorphosed adult. × 825.

FIG. 10. Cell from cyst near middle portion of protuberance in newly metamorphosed adult. × 825.

FIG. 11. Longitudinal section through the peritoneal sheath and tunica propria of the ovariole. *a*—epithelial membrane; *l. mus.*—longitudinal muscle layer; *c. mus.*—circular muscle layer; *p. s.*—peritoneal sheath; *t. p.*—tunica propria. × 825.

FIG. 12. Diagram of female gonads and associated structures. *b. cop.*—bursa copulatrix; *cm. ovd.*—common oviduct; *ov*—ovariole; *spth*—spermatheca; *spth. gl.*—spermathecal gland.



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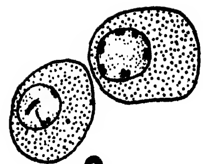

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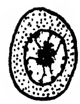

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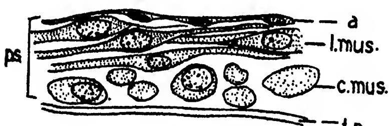

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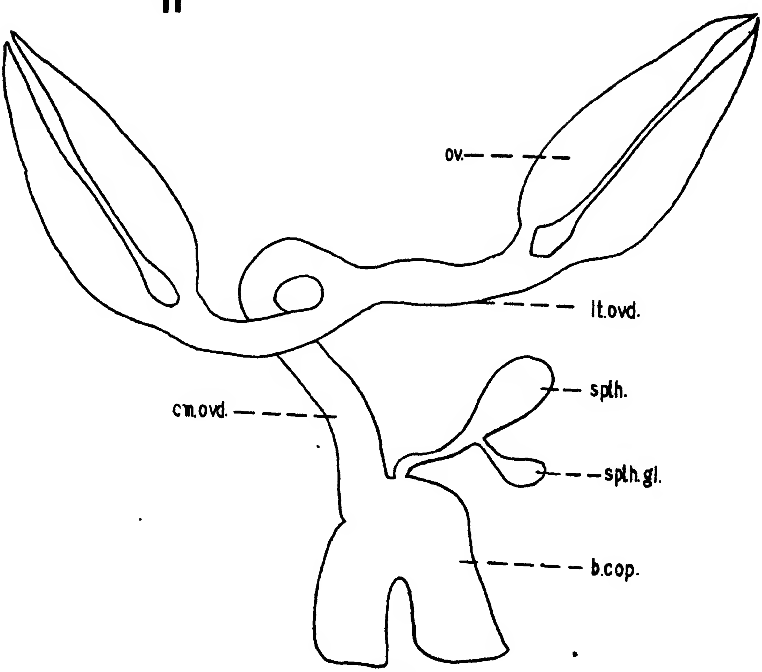

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The little nipple-like protuberance at the extreme distal tip of the testis is also an interesting and unusual structure. It is here that the first stages of spermatogenesis evidently occur (fig. 7–1). As the development of the male sex cells ensues, they migrate away from this region toward the basal portion of the testis. They are prevented from entering the open funnel-like sperm duct by the epithelial arch which guides them around the opening (2) into the proximal portion of the testis between the testicular septa (3). The significance of the mass of cells enclosed by the non-cellular layers (fig. 3, *d*) could not be determined.

In a newly metamorphosed adult the lower part of the testis (fig. 7—3 and 4) is filled with male sex cells undergoing the early phases of meiosis. Presently, some cysts of cells can be seen in the early periods of spermiogenesis, or transformation. These transforming cells seem to exhibit no regular or definite arrangement either transversely or longitudinally. That is, metamorphosing cells can be found near both the peripheral and the central regions of the gland, as well as in both the distal and proximal regions. As the breeding season approaches and the transformation into spermatozoa has been nearly completed, the almost mature spermatozoa tend to gather in the central region (5). Then they migrate distally along the sperm duct, pass under the epithelial arch (6), around the rim of the funnel, and into the efferent sperm duct (7). As the bunches of spermatozoa pass up around the sperm duct under the epithelial arch and around the rim into the funnel, they seem to be subjected to some sort of whirling movement which tends to wrap the long tails around into little balls. However, as they pass out of the sperm duct this ball-like condition disappears and the individual spermatozoa pass into the seminal vesicle.

Although a detailed and extensive study of the stages of spermatogenesis in *Passalus* was not made or intended, it is quite obvious that the conditions of this process are somewhat different from those typcially found in insects. In the blind-sac, or club-like follicles of most coleopteran testes the process of spermatogenesis originates at the distal apical region and continues in a wave-like fashion toward the proximal portion. At any particular region of the follicle all of the developing cells are in approximately the same phase. Thus, very definite regions

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EXPLANATION OF PLATE IV

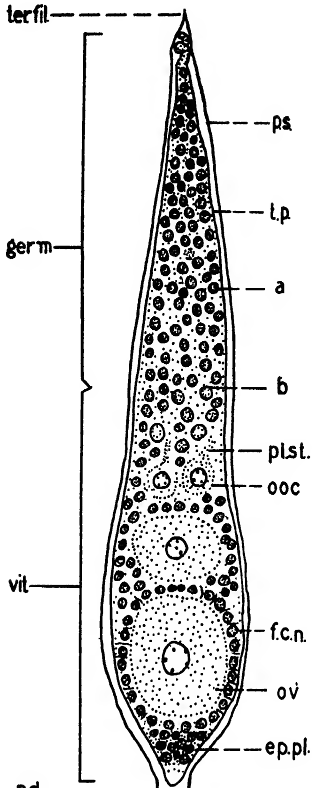
FIG. 13. Diagrammatic longitudinal section through the ovariole. *a*—nucleus of undifferentiated egg cell; *b*—nucleus of enlarging egg cell; *ep. pl.*—epithelial plug; *f. c. n.*—follicle cell nucleus; *germ.*—germarium; *ooc*—enlarging oocyte; *ov*—large egg cell with follicle cell envelope; *pd*—pedicel; *pl. st.*—plasmatic strand; *p. s.*—peritoneal sheath; *ter. fil.*—terminal filament; *t. p.*—tunica propria; *vit*—vitellarium.

FIG. 14. Small ovum just beginning to enlarge. × 825.

FIG. 15. Group of cells from anterior region of vitellarium. *a*—undifferentiated cell; *b*—cell with enlarged nucleus and pseudopodia-like cytoplasmic processes. × 825.

FIG. 16. Enlarging oocyte showing traces of plasmatic strand. × 345.

FIG. 17. Group of follicle cells forming the epithelial plug beyond the last and largest ovum in the egg tube. *f. c.*—follicle cell of epithelial plug; *ov*—last ovum in egg tube. × 345.



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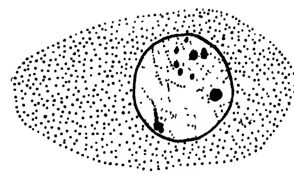

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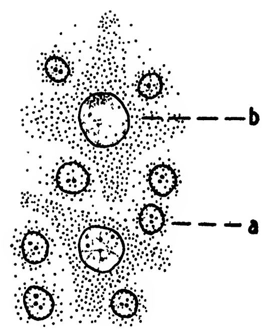

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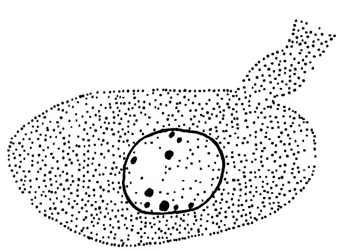

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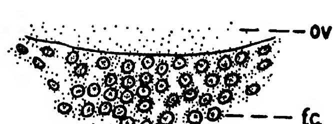

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can be identified, such as: "zone of growth," "zone of division and reduction," "zone of transformation," etc. When a spermatogonium increases in size, the process takes place in the "zone of growth." When the spermatocytes undergo their meiotic activities and became spermatids they are located in the "zone of division and reduction." And when spermatids begin to metamorphose into spermatozoa this activity takes place at the "zone of transformation."

In *Passalus* there does not seem to be any definite region where the cells are always in one particular phase. It is true, however, that the spermatogonia are located at the extreme apex, and this region could properly be called the germarium. But in the region near the sperm duct, for example, the cells may be in early meiotic activity, or they may be nearly complete spermatozoa, depending upon the age of the beetle.

The enveloping peritoneal sheath corresponds to that usually found surrounding the typical testes of beetles, but the fact that it is composed of a sheath of cells enclosed by two thin non-cellular layers is rather unusual. This is especially true in the region of the protuberance, where it becomes even more complex.

STRUCTURE OF THE FEMALE GONADS

While the female gonads of *Passalus* conform more closely to the typical coleopteran pattern than do the testes, the ovaries do exhibit several peculiarities in structure.

The fact that the paired ovaries are each composed of two slender, elongate, banana-shaped ovarioles is not unusual, nor is the fact that each is enclosed by two investing sheaths—the outer peritoneal sheath and the inner non-cellular tunica propria.

But the structure of the outer sheath is interesting because it is made up of several component parts (fig. 11). In the internal portion this sheath is composed of a circular layer of muscle fibers, and just external to this layer, a layer of longitudinal muscles. Imms (1938) states that a muscle "reticulum" is often found in the peritoneal sheath, which implies a network of branching or anastomosing fibers. In *Passalus* both muscle layers are apparently composed of single, individual muscle fibers. However, while they are not absolutely uniformly or regularly arranged, there is nothing to indicate a "reticulum" composed of branching or anastomosing fibers. Rather, the fibers seem slightly twisted about each other in a somewhat felt-like arrangement.

The muscles of insects are invariably described as all being of the striated type. However, not many authors have dealt with the muscles of the gonads proper, but only with the muscular tissue in the efferent ducts or copulatory organs of the reproductive system.

Neither the longitudinal nor the circular muscles of the peritoneal sheath in *Passalus* exhibit definite transverse or longitudinal striations. Instead, the individual fibers resemble the spindle-shaped smooth muscles characteristic of the "involuntary" muscles of vertebrates. In the region of the oviduct the striations can be recognized without much difficulty. As there is a much greater amount of muscular tissue present here, it may well be that the mere quantity of fibers emphasizes the

striated condition. On the other hand, there seems to be no obvious reason why a type of smooth muscle should not be found in some structures in insects. Perhaps, then, the ovariole sheath in ***Passalus*** does possess a relatively rare type of non-striated muscle fiber.

An outer thin membrane lying next to the hemocoel surrounds the longitudinal muscle layer and resembles a typical mesothelium (fig. 11, *a*). This thin layer undoubtedly corresponds to the "peritoneal membrane" often described in other insects.

While the tunica propria is typically described as a "thin structureless membrane," it is perhaps more consistent to refer to it in ***Passalus*** as a non-cellular transparent sheath. And likewise while some authors call the peritoneal sheath an "epithelial" membrane, and others, a connective tissue coat, in ***Passalus*** it is obviously a complex sheath of two layers of muscles covered externally by an epithelial membrane. However, the term "peritoneal sheath," is entirely appropriate and adequate for this investing coat.

According to Deegener (1914), Imms (1938), Snodgrass (1935) and others, the typical ovariole of the Coleoptera-Polyphaga belongs to the acrotrophic, or telotrophic type, where the nurse cells are found at the tip of the ovariole. Although the spiral-like tip of the germarium in ***Passalus*** was not carefully studied cytologically, it seems quite likely that it does perform some sort of nutritive function as would be expected in this beetle. The fact that much bright staining material is present at the tip of the ovariole, and the fact that at least the smaller developing egg cells possess plasmatic strands definitely indicate that the ovariole in ***Passalus*** is the typical acrotrophic type. However, direct protoplasmic connections could not be demonstrated between the oocytes and the distal spiral tip. Inasmuch as large globules of a similar bright-staining material were frequently seen in the germarium proper, it is quite evident that some sort of protoplasmic connection does exist.

No plasmatic strands were seen on the egg cells which were enveloped by follicle cells, and it is probably true that the smaller oocytes receive nourishment from the apical feeding chamber via the plasmatic strands until they acquire a follicle cell envelope of their own.

Because the significance of the terminal filament can be more easily interpreted in light of its development, the consideration of this structure will be postponed for the present.

The remainder of the ovariole is also quite typical in construction (fig. 13). The vitellarium contains the developing egg cells and surrounding follicle cells. Beyond the last and largest ovum is the epithelial plug of follicle cells, which prevents unripe ova from escaping into the oviduct.

SUMMARY

1. The structure of the gonads in the male ***Passalus cornutus*** is rather atypical, and in many respects differs from the characteristic conditions usually found in beetles. In the young adult the gonads consist of two pairs of bulb-shaped testes, one pair on either side of the body. Each of the four testes is surrounded by a peritoneal sheath composed of a sheet of cells bounded by two thin non-cellular layers.

A central funnel-shaped sperm duct courses almost the whole length of the testis and leads into the seminal vesicle and vas deferens. The gland is divided into 20 to 30 long, wedge-shaped sections by epithelial testicular septa which radiate around the central sperm duct, and extend almost the whole length of the testis.

2. At the distal tip of each testis there is a peculiar little nipple-like protuberance the apex of which can be considered as the germarium, since here the early stages of spermatogenesis take place. Just adjacent to the little hillock is an epithelial arch of dense cells that extends dome fashion over the funnel-like mouth of the sperm duct. This arch guides the migrating sperm cysts from the protuberance into the testis proper, and prevents the escape of immature sex cells. The sperm cysts continue their maturation within the confines of the testicular septa. When the spermatozoa are to be discharged, they migrate distally toward the tip of the testis, pass under the epithelial arch and into the flared-out opening of the sperm duct.

3. The ovary on each side of the body is composed of two elongate, banana shaped ovarioles that join each other at their bases and are continuous posteriorly with the lateral oviduct. Each ovariole is enveloped by two coats. The outer peritoneal sheath is made up of an inner circular layer and an outer longitudinal layer of non-striated muscles. These in turn are covered by a thin epithelial membrane lying next to the hemocoel. A transparent non-cellular tunica propria is located between the peritoneal sheath and the cells of the ovariole.

4. The ovariole corresponds to the typical acrotrophic type usually found in the Coleoptera-Polyphaga, and consists of the following regions: (a) a distal terminal filament, (b) a germarium, where at the spiral distal tip there is a bright-staining nutritive chamber, and at the basal portion the cells are in an undifferentiated condition; (c) a vitellarium, where the oocytes become enveloped by follicle cells and develop into mature ova, and which contains an epithelial plug that prevents the immature egg cells from escaping; and (d) a pedicel, or stalk, which attaches the ovariole to the lateral oviduct.

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THE GENUS SANCTANUS IN NORTH AMERICA INCLUDING THE MEXICAN SPECIES

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The Genus *Sanctanus* was erected by Ball[2] in 1932 to include a small group of species formerly placed in *Scaphoideus*. He cited *Scaphoideus sanctus* Say as the genotype. In addition he placed *fasciatus* Osb., *cruciatus* Osb., *orbiculatus* Ball, *aestaurium* DeL. & S., *limnicolus* Osb., *eburneus* DeL. and *fusconotatus* Osb. in the Genus *Sanctanus*. Later Oman,[3] 1934, made a key to the species of the genus in which he included *tectus* which he described at that time. In 1938 Beamer[4] described *balli* as closely related to *sanctus*. This previous work included largely North American species. Recently the writers have been studying a large amount of material belonging to this genus, which was collected in Mexico. As a result it has been found that five new species, *similarus*, *pallidens*, *galbus*, *apicalis* and *elongatus* are closely related to *sanctus* and *balli*. One other, *elegans*, is more closely related to *orbiculatus*. In the *fasciatus* group there are apparently five species occurring in Mexico, four of which, *virgatus*, *marginellus*, *sonorus* and *dampfi*, are apparently new and closely related to *fasciatus* and *cruciatus*. In color pattern many of these species could scarcely be distinguished from closely related forms unless the male genital characters are used. In the *sanctus* group the aedeagus is quite similar in type in several of the species but the character of the style will distinguish them very easily. In the *fasciatus* group the aedeagus and styles are similar in type but the characters of the plates will separate these into species and the color patterns are of assistance in a few cases. The male genitalia of *fusconotatus* and *aestuarium* are very similar and unique. The color pattern of the head will distinguish these species and the vertex in *fusconotatus* is apparently more produced than in *aestuarium*.

During this study most of the types have been examined and the genital structures studied. The types of *cruciatus*, *fasciatus*, *neglectus*, *fusconotatus*, *limicolus* and *picturatus* in the Osborn collection and the types of *aestuarium* and *eburneus* in the senior author's collection have been available at the Ohio State University. The type of *orbiculatus* Ball and *tectus* Oman have been examined at the National Museum. The authors desire to express their appreciation for the courtesies extended by Prof. J. N. Knull and Dr. J. S. Caldwell for the examination of types in the collections of these two institutions.

[1]The authors wish to acknowledge with appreciation the assistance obtained from a Grant-in-Aid from the Sigma Xi research fund.

[2]Jour. Wash Acad. of Sci. 22: 10. 1932.

[3]Proc. Ent. Soc. of Wash. 36: 75–76. 1934.

[4]Can. Ent. 70: 244. 1938.

Genus **Sanctanus**

The genus is characterized by having a somewhat flat vertex which is acutely angled with the front. The elytra have a second cross nervure between the sectors and the second anteapical cell is constricted and divided. The first anteapical cell is usually quite short, narrowed at both ends with one or more reflexed veinlets to the costa. Most of the species of the genus have a dark saddle-like marking or a dark cruciate spot on the elytra which usually obscures the venation.

The genus seems to contain two allied groups of species which differ somewhat in structure and appearance. Two subgenus names are therefore proposed. The forms with a produced pointed head are placed in the subgenus *Sanctanus* with *sanctus* Say as the type. The broad blunt-headed species are placed in the subgenus *Cruciatanus* with *cruciatus* Osborn as the type.

The subgenus *Cruciatanus* is characterized by a broad blunt head and with a zigzag broad dark band which does not reach the costal margin. The male styles in this group are not notched on the outer margin before the apex but are curved and abruptly narrowed at about the middle to form long slender processes on the apical half. The aedeagus has a shallow excavation on the dorsal surface near the middle on the basal half. The six species, *cruciatus*, *fasciatus*, *marginellus*, *dampfi*, *sonorus* and *virgatus* belong to this subgenus.

KEY TO SPECIES

1. Elytra white with a median brown cruciate mark across posterior two-thirds of clavus extending to costa and forming a broad white marginal band along scutellum across base of elytra and another white oblique band from apex of clavus to costa across base of anteapical cells—(*sanctus* group) 2

1'. Elytra without a brown median "saddle" reaching to costa and forming a white marginal band along scutellum and across anteapical cells.... 8

2. (1). Vertex and above definitely tinted with yellow, face and beneath bright orange yellow; male aedeagus decidedly broadened or inflated at middle .... **gelbus**

2'. Vertex milky white or pale yellow, face and beneath pale, not orange. Male aedeagus not strongly inflated at middle 3

3. (2'). A marginal row of spots just above margin of vertex larger and appearing more connected in a broken line .... **pallidens**

3'. Spots above margin of vertex minute and rounded if present, not appearing elongated or connected 4

4. (3'). Apical portion of male styles beyond constricted portion as long or longer than basal half. Aedeagus in ventral view with a pair of separated broadened processes produced beyond apex .... **sanctus**

4'. Apical portion of styles beyond constriction less than half the length of basal portion. Aedeagus in ventral view with apical processes pointed 5

5. (4'). Apical portions of styles slender, elongate, fingerlike 6

5'. Apical portions of styles broadened beyond constriction to width of style before constriction 7

6. (5). Style abruptly notched on outer margin to form fingerlike apex. Aedeagus enlarged just before apex, broadened on ventral side.... **balli**

6'. Style only faintly notched to form fingerlike apex. Aedeagus with a dorsally produced process just before apex .... **similarus**

7. (5'). Style indented at middle on broad apex forming a pair of "cat ear" processes. Aedeagus slightly broadened at middle and tapered to a pair of sharp pointed processes .... **elongatus**

7'. Style with apical margin straight, sloping to outer margin. Apical portions of aedeagus slender not broadened at middle.......... **apicalis**

8. (1'). Elytra white with a small brown spot on middle of clavus and a brown band across inner anteapical, apical portion of central anteapical and the first apical cells. Corium white, unmarked......... **eburneus**

8'. Elytra with dark markings on costa or corium in the form of spots or stripes..9

9. (8'). Elytra salmon colored with dark markings........................10

9'. Elytra not salmon colored; with dark bars or stripes.................11

10. (9). Vertex with two apical black spots, pronotum unmarked, corium of elytra without longitudinal white stripes................. **orbiculatus**

10'. Vertex unmarked, pronotum with two large black spots on humeral angles, corium of elytra with a broad white longitudinal stripe.. **elegans**

11. (9'). Vertex white with two transverse brown bands between the eyes. Elytra dark brown with white veins, appearing longitudinally striped.. **virgatus**

11'. Elytra with dark spots or zigzag bands, not appearing longitudinally striped..12

12. (11'). Elytra with numerous supernumerary veinlets on the anteapical cells.. **limicolus**

12'. Without supernumerary veinlets on anteapical cells of elytra..........13

13. (12'). Dorsal color pattern consisting of brown or yellowish brown and ivory. Brownish area on disc of corium not broken by broad white or pale veins—(*fasciatus* group)....................................14

13'. Dorsal color pattern lacking in distinct brown and ivory contrasts. Markings on corium consisting mostly of brownish intra-cellular infuscations which are darker around the margins. Veins on disc of corium broad and pale...18

14. (13). Entire upper surface embrowned with a row of elongated brown spots forming a broken marginal line just above margin of vertex.. **marginellus**

14'. Dorsal surface with contrasted areas of milky white and brown........15

15. (14'). Pronotum white with a broad broken brown band across middle. Scutellum white with three dark brown spots, one at apex and one in each basal angle. Male plates tapered to form blunt rounded apices.. **cruciatus**

15'. Pronotum and scutellum brownish with faint markings. Male plates broadly rounded, not narrowed to blunt rounded apices............16

16. (15'). Male plates decidedly longer than styles.........................17

16'. Male plates about the same length as styles.................. **fasciatus**

17. (16). Vertex distinctly produced and bluntly angled; male plates broadly convexly rounded to straight inner margins................. **sonorus**

17'. Vertex short, blunt, broadly rounded; male plates narrow, convexly rounded from both inner and outer margins to form a broadly rounded apical margin which is almost as broad as basal width of plate.. **dampfi**

18. (13'). Upper half of face uniformly black. Vertex without heavy dark markings on disc..19

18'. Black marks on upper portion of face consisting of broken transverse band with white transverse bars. A pair of large round black spots between anterior portion of eyes on disc................ **tectus**

19. (18). With dark fuscous marks above margin on anterior portion of vertex next each eye.................................... **fusconotatus**

19'. Vertex with pale orange markings on disc; no dark markings above margin.. **aestuarium**

Sanctanus sanctus (Say)

Jassus sanctus Say. Jl. Acad. Nat. Sci. Phila. VI, p. 307, 1831, Compl. writ. II, p. 383.

A white species with a brown cruciate mark across middle of elytra. Length 5 mm.

Vertex rather sharply angled, almost as long at middle as basal width between eyes.

Color: White, often gray in appearance and tinted with yellow or tawny. Vertex with a pair of minute spots at apex. Elytra white with a brown cruciate mark at middle and another dark band across the cross veins and apex.

Genitalia: Female last ventral segment almost truncate with a slight median notch. Male plates gradually narrowed on outer margins to form sharp-pointed apices. Style elongate, notched on outer margin before middle, the apical half narrow, finger-like and blunt at apex. The aedeagus in ventral view is broadened at apex with a rounded excavation at middle, forming a pair of blunt, truncate apical processes.

This is the common species of this genus throughout the eastern United States.

Sanctanus balli Beamer

Sanctanus balli Beamer. Can. Ent. 70: 224, 1938.

In general appearance and coloration resembling *sanctus*, but with distinct genitalia. Length 5–5.75 mm.

Vertex produced and angled, but wider between eyes at base than median length.

Color: Milky white, tinted with yellow, vertex with a pair of minute darker spots near apex and the two larger irregular angled dashes near base. Pronotum and scutellum pale with dark mottling. Elytra white with the typical brown cruciate mark near middle and a narrow fuscous stripe on cross veins which is Y-shaped. Cruciate mark at middle, darker margined.

Genitalia: Female last ventral segment with lateral angles slightly curved to a posterior margin which is slightly sinuate, bearing a slight, narrow V-shaped notch at middle. Male plates with outer margins roundly produced to sharp apices. Male style rather short, a deep notch on outer margin about one-third the distance from apex, the apical finger process blunt at apex. Aedeagus in ventral view enlarged just before apex, then tapered to a pointed spear-like tip.

This species has been reported only from Arizona.

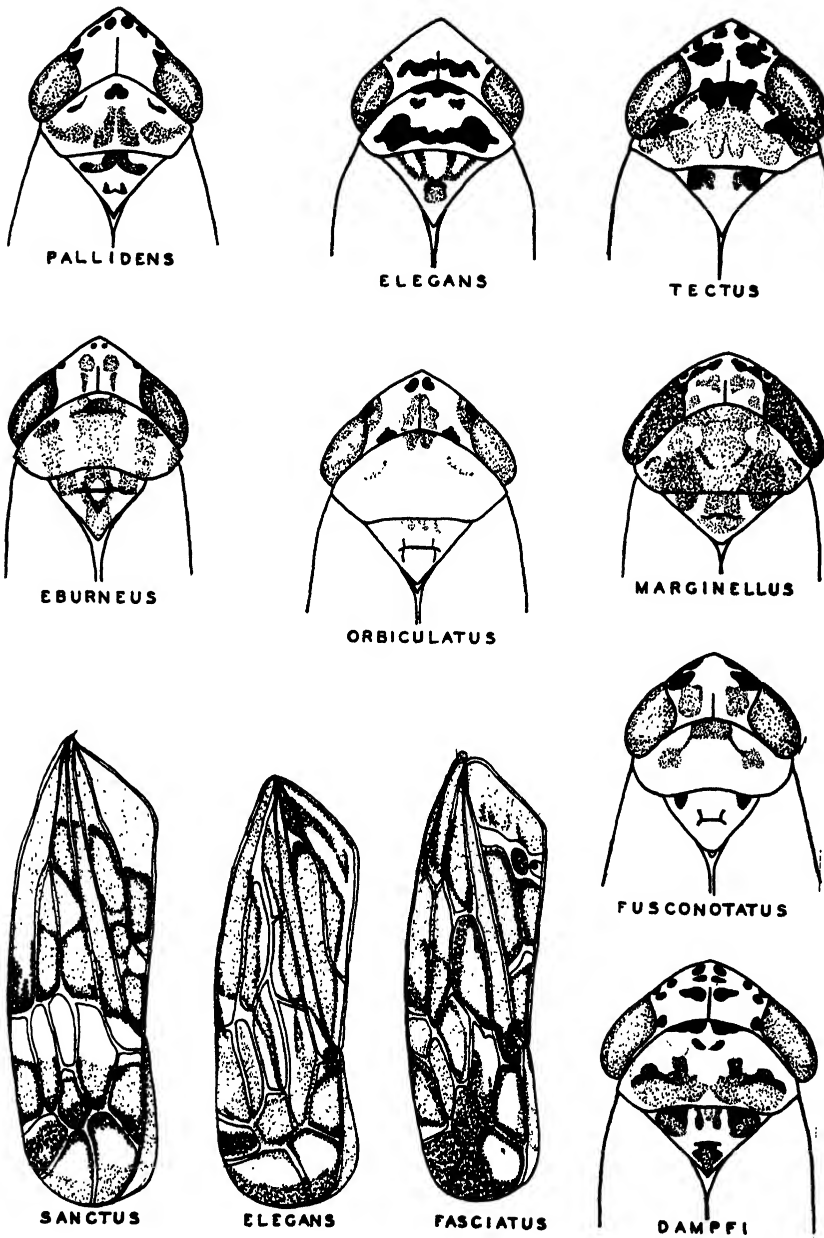
Sanctanus similarus n. sp.

Resembling *sanctus* in form and general appearance but paler and with different male genitalia. Length 4–4.5 mm.

Vertex bluntly angled, about as long at middle as basal width between eyes.

Color: Face pale with traces of a few arcs on upper portion. Ocelli black. Vertex dirty white, unmarked. Pronotum and scutellum white, tinged with green. Elytra white with a pale brown cross extending from costal margin across clavus, forming a small round white spot on clavus next suture. A brownish spot bordering the cross veins between apical and anteapical cells.

Genitalia: Female last ventral segment roundedly produced from base with a portion of the underlying segment visible at each side. Male style with apical third distinctly narrowed and bent outwardly. The apex tapered to a bluntly pointed tip. Plates about the length of pygofer, elongate, triangular, acutely pointed. The aedeagus is a single



Dorsal views of head, pronotum and scutellum of species of *Sanctanus* as labeled. Lower left—view of left elytron of three species as labeled.

tubular process with apex bent downwardly, a pair of lateral processes at apex are turned upward.

Holotype male collected at Huetamo, Gro., August 22, 1933, (M. F. 3100), by Dr. Dampf. *Allotype* female taken at Tuxtla, Gutierrez, July 29, 1936 (M. F. 1055), by Dr. Dampf. Male and female *paratypes* from Huetamo and Iguala, Gro., Sept. 11, 1939, and Oct. 25, 1941, collected by Good, Plummer and DeLong.

Sanctanus pallidens n. sp.

Resembling *sanctus* in general form, but with different color markings and male genitalia. Length 4–4.5 mm.

Vertex appearing sharply angled in female, blunter in male, a little wider between eyes at base than median length.

Color: Face washed with pale brown, traces of arcs on upper portion, usually a brown transverse band between antenna. Vertex yellowish in male with a pair of brown apical spots and a fainter spot next each eye. Eyes and ocelli red. Vertex in female sordid yellow, with the four spots somewhat coalescing to form a broken marginal line. Other irregular dull spots are on disc and base. Pronotum and scutellum dirty white, tinged with green. Elytra pale dirty white, tinged with green. The cross mark from costal margin extending across clavus is pale brown, often scarcely visible in males. There is a brown spot bordering the cross veins of the anteapical cells.

Genitalia: Female last ventral segment roundedly produced from base to form a slightly concave posterior margin which is embrowned at middle. The lateral portions of the underlying segment are exposed on either side. Male plates decidedly shorter than pygofer, triangular, with blunt apices. Style rather deeply narrowly notched just before apical fifth which is a fingerlike process. Aedeagus elongate in lateral view, slightly broadened at middle, tapered to a narrow apex which is slightly upturned. In ventral view it is bifid on apical half with the two straight portions proximal.

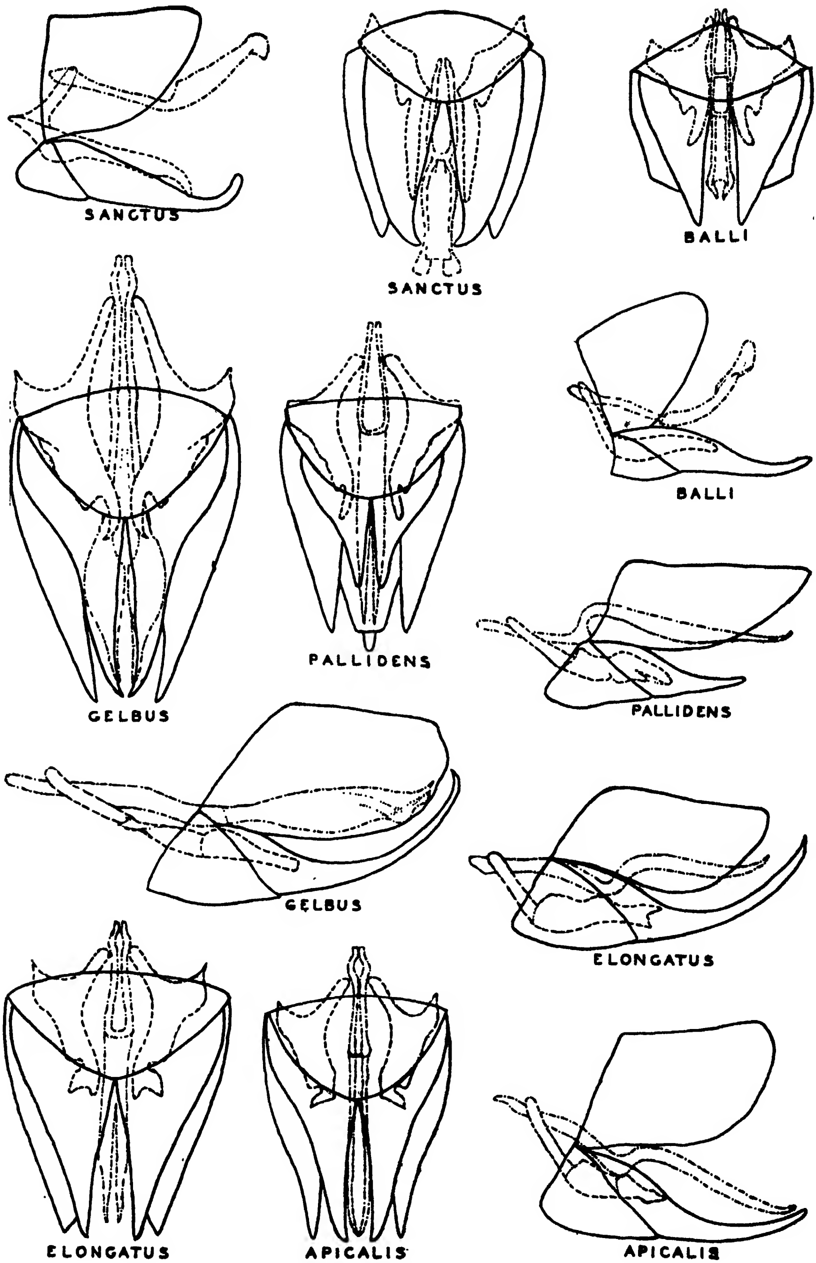
Holotype male, *allotype* female and male and female *paratypes* collected at Iguala, Gro., Sept. 11, 1939, by Plummer and DeLong and October 25, 1941, by Good and DeLong. Male and female *paratypes* collected at Huetamo, Gro., August 22, 1933 (M. F. 3100), and Yaqui Valley, Sonora, August 16, 1927 (M. F. 1295A), by Dr. Dampf.

Sanctanus gelbus n. sp.

Resembling pale specimens of *sanctus* in general appearance, but with distinct male genitalia. Length 4–4.75 mm.

Vertex strongly angularly produced, a little wider between eyes at base than median length.

Color: White, with pale brown markings on elytra. Vertex, pronotum and scutellum white, washed with yellow or orange. Face and beneath yellow to orange, the males are usually more darkly marked. Elytra milky white with a rather pale brownish cross extending from costal margin across clavus with a small enclosed white spot on clavus. A pale brownish spot across apices of elytra, veins white, rather heavily bordered with dark brown.



Lateral and ventral views of the caudal portion of the male abdomen showing the genitalia in position for species of *Sanctanus* as labeled.

Genitalia: Female last ventral segment more than three times the length of preceding segment. Strongly roundedly produced from base to form a broadly rounded posterior margin which is slightly broadly notched at middle. Male plates as long as pygofers, convexly rounded at apex, slightly concave on inner margins and acutely pointed. Style deeply, broadly notched on outer margin one-fifth the distance from apex, the apical process narrowed, curved outwardly at tip and acutely pointed. Aedeagus distinctly inflated at middle both in lateral and ventral views, rapidly narrowed to a sharp pointed apex.

Holotype male, *allotype* female and male and female *paratypes* collected at Puenta de Ixtla, Mor., Mexico, October 21, 1941, by Good and DeLong. Male and female *paratypes* collected at Iguala, Guerrero, Mexico, September 11, 1939 by Plummer and DeLong; and at Taxco, Gro., K-155, October 6, 1945, elevation 5,500 feet, by Balock, Elliott, Hershberger and DeLong; Tierra Colorado, Gro., K-271, October 5, 1945, elevation 1,500 feet, collected by Balock, Elliott, Hershberger and DeLong; Cuernavaca, Mor., K-6-east, Sept. 25, 1945, elevation 4,800 feet, by Plummer, Shaw, Elliott, Hershberger and DeLong.

Sanctanus apicalis n. sp.

Resembling *sanctus* in general form and appearance but with spots on the vertex and different male genitalia. Length 4–4.5 mm.

Vertex strongly produced, bluntly angled at apex, a little broader between eyes at base than median length.

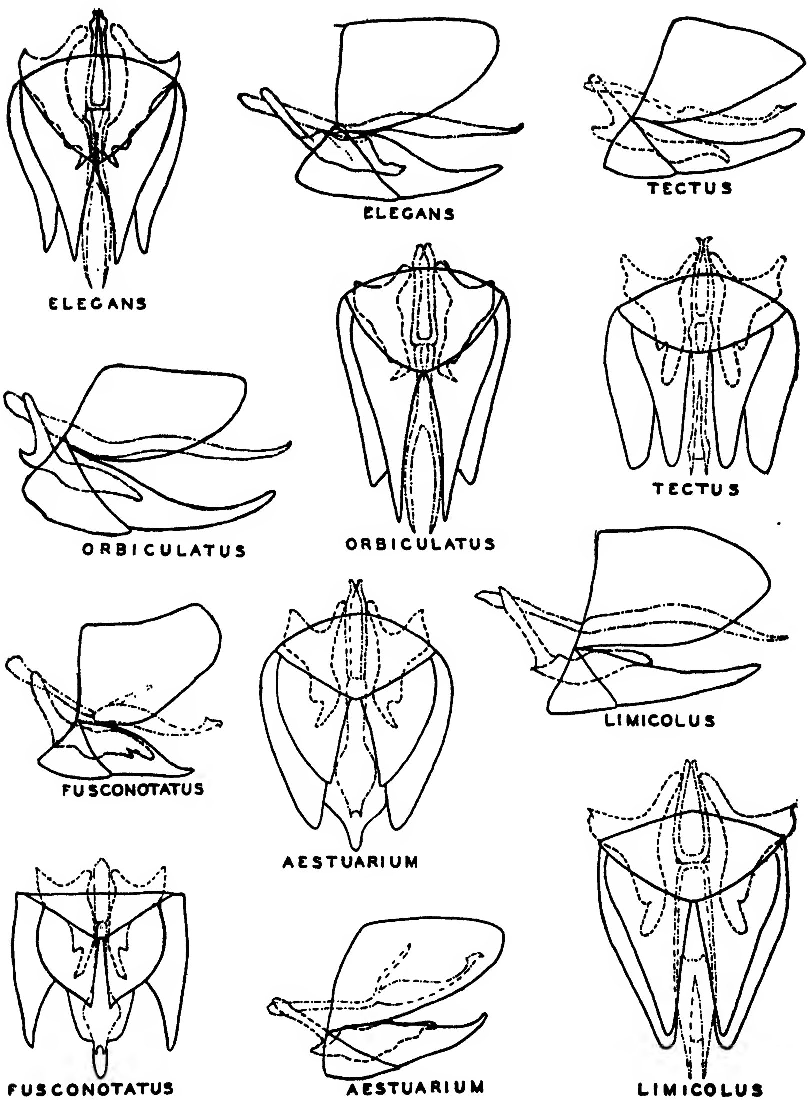
Color: Face yellow with a brown wavy line just beneath margin of vertex. Vertex, pronotum and scutellum dirty white washed with yellow or greenish yellow. Ocelli dark and a pair of minute separated spots just above apex. Elytra milky white marked as in *sanctus* with a brown cross extending from costa each side across clavus. The arms of the cross on each side are broad, pale brown and bordered with darker brown. They enclose a triangular white spot on costa and a small round white spot on clavus. A brown area also extends from apex of clavus to apical costal area enclosing the anteapical cross veins which are heavily margined with brown.

Genitalia: Female last ventral segment produced from near base to form a roundedly produced posterior margin which is slightly notched at apex. The portion of the underlying segments are exposed and plainly visible at each side. Male plates as long as pygofers, narrowed to blunt apices. Style rather broad, deeply notched on outer margin, apex broad, truncate. Aedeagus in lateral view long and narrow, in ventral view bifid on apical two-thirds, forming a pair of slender processes which are separated and converge at apices.

Holotype male and *allotype* female collected at Tuxtla, Gutierrez, Chiapas, July 29, 1936, by Dr. Dampf (M. F. 1055). Male and female *paratypes* collected at Iguala, Gro., September 11, 1939, by Plummer and DeLong and at Mainari, Son., August 11, 1927, by Dr. Dampf (M. F. 1282A).

Sanctanus elongatus n. sp.

Resembling dark specimens of *sanctus* in general appearance. With four marginal spots on vertex and with distinct male genitalia. Length 4–4.5 mm.



Lateral and ventral views of the caudal portion of the male abdomen showing the genitalia in position for species of *Sanctanus* as labeled.

Vertex angularly produced, about one-sixth wider between eyes than median length.

Color: Vertex pale yellow, a pair of minute brown spots just above apex and a spot above each ocellus. Pronotum pale anteriorly, dusky posteriorly. Scutellum with two small round spots just back of pronotum. Elytra milky white with the brown cross extending from the costal margin across clavus and forming the white spot on costal margin and the spot on clavus. The cross is dark brown to black. A brown spot covers the posterior portions of the anteapical cells and the cross veins. The veins are white, margined with dark brown. Face yellow below, dusky above. A transverse brownish band just beneath antennal sockets, brownish arcs above and a narrow sinuate line just beneath margin.

Genitalia: Female last ventral segment roundedly produced from base to form a broadly rounded posterior margin which is slightly notched at middle, with a black spot on either side. Portions of the underlying membrane are exposed at each side of the lateral margins. Male plates as long as pygofer tapered to pointed apices. Style deeply notched on outer margin near apex forming a broad apical portion which is concave apically. Aedeagus in lateral view long, narrow, and curved. In ventral view bifid on apical half, the apical portions of the two processes narrowed to slender tips.

Holotype male, *allotype* female and male and female *paratypes* collected at Uruapan, Mich., Mexico, October 1, 1941, by Plummer, Caldwell, Good and DeLong; Rio Tuxpan, Mich., K-185, September 29, 1945, elevation 6,000 feet, and at Morelia, Mich., September 30, 1945, elevation 6,500 feet, by Plummer, Hershberger, Elliott and DeLong.

Sanctanus orbiculatus Ball

Sanctanus orbiculatus Ball. Jour. Wash. Acad. Sci. 22: 11, 1932.

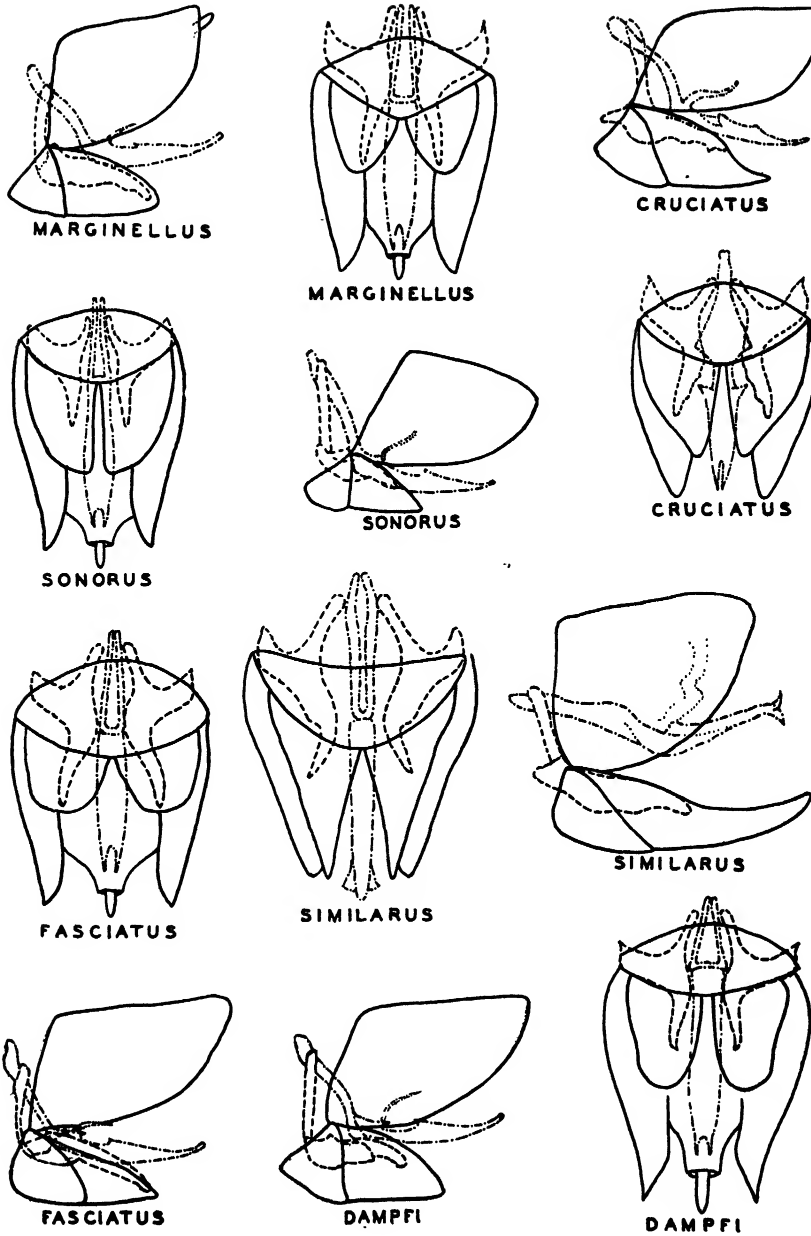
A distinctly marked species, salmon in color with white markings and four black spots on margin of vertex. Length 4–5 mm.

Vertex obtusely angled, broader than long and angled with front at apex.

Color: Vertex white, apex with a pair of spots above and a short angular line beneath. A larger pair of spots surround the ocelli and a large pair on posterior portion. Pronotum and scutellum pale in the female, salmon colored in the male. Elytra pale salmon tinted with smoky in the male, the scutellar margins broadly white in the female. There is a narrow white band across the basal portions of the anteapical cells, beyond which the nervures are white with smoky margins. The second apical cell contains a large round eye-like black spot.

Genitalia: Female last ventral segment slightly produced at middle of posterior margin, male plates long, rather slender, acutely triangular. Style rather short and broad, rather deeply notched on outer margin near apex with tip bent outwardly and sharply pointed. Aedeagus in lateral view appearing long and slender, in ventral view the apical half is bifid with the two portions curved and separated.

This species was described from the southwestern United States and is not known to occur in any other area.



Lateral and ventral views of the caudal portion of the male abdomen showing the genitalia in position for species of *Sanctanus* as labeled.

Sanctanus elegans n. sp.

Somewhat resembling *orbiculatus* but with a different color pattern and different male genitalia. Length 3.5–4.5 mm.

Vertex produced and bluntly angled, a little wider between eyes at base than median length.

Color: Face pale yellow with a narrow black band just beneath margin. Vertex white with a narrow black transverse broken band between eyes near base, the outer ends of which are curved posteriorly. Pronotum white with a black mark at middle on anterior margin, a large black spot near posterior margin just back of each eye and a minute spot near each, between them and just before posterior marking. Scutellum milky white to creamy, basal angles often a little darker. Elytra orange yellow with distinct black and white markings. There is a large black spot just beyond base of each elytron. A brown bordered white stripe extends along margin of scutellum and along suture to apex of clavus. This encloses a small spot and black line on anal portion of wing. Another brown margined white band is just anterior to apical cross veins and extends about one-third the distance to base on outer claval vein. A third white stripe extends along the inner branch of the first sector its entire length, and a fourth arises on the costal margin at the anterior end of the first anteapical cell and follows both veins to its apex. Apical cross veins white, brown banded, and apex of elytra with a broad brown margin. Beneath yellowish.

Genitalia: Female last ventral segment roundedly produced from near base to slightly concavely rounded posterior margin. The lateral portions of underlying segment visible at each side. Male plates as long as pygofer, sharply pointed. Style abruptly narrowed just before apex, forming an outwardly directed sharply pointed apical process. Aedeagus in lateral view straight, tapered to a narrow tip. In ventral view bifid, about one-third the distance from base with the two processes long, tapered and distinctly separated.

Holotype male, *allotype* female and male and female *paratypes* collected at Tierra Colorado, Gro., K-271, October 5, 1945, by Balock, Elliott, Hershberger and DeLong. *Paratype* males and females from Cutzamala, Gro., August 20, 1930 (M. F. 1768); Pungarabato, Gro., August 22, 1930 (M. F. 1769), both collected by J. Parra. *Paratype* males and females also from Coyuca-Catalon, Gro., August 24, 1930 (M. F. 1771); Yetla, Gro., August 12, 1930, (M. F. 1756); San Miguel, Gro., (M. F. 1759); Balsas, Gro., August 15, 1930 (M. F. 1754); Vejuco, Gro., September 3, 1930 (M. F. 1790); Zirandera, Gro., August 29, 1930, (M. F. 1786); Pasade Vecas, Gro., September 3, 1930 (M. F. 1792), collected by J. Parra. *Paratypes* from El Mante, Tamaul., October 26, 1930, (M. F. 1775); Yaqui Valley, Sonora; Huetamo, Mich., August 22, 1933, (M. F. 3100) and Mexico (M. F. 1773) and (M. F. 1777), collected by Dr. Dampf. *Paratypes* from Iguala, Gro., September 11, 1930, and October 25, 1941, were collected by Plummer, Good and DeLong.

This is a common meadow species occurring on herbaceous plants.

Sanctanus tectus Oman.

Sanctanus tectus Oman. Proc. Ent. Soc. Wash. 36: 75, 1934.

Resembling *Polyamia arundineus* in color pattern but apparently

related to *fasciatus* and *cruciatus* with a more angled vertex. Length 4–4.5 mm.

Vertex rather strongly produced and angled, a little wider between eyes at base than median length.

Color: Vertex pale with a pair of small black spots at the apex and a large pair, irregular in shape, on the disc near the ocelli. The large spots fused with the black band on the front. A pair of small black spots on posterior portion of vertex. Pronotum with a rectangular black spot on the anterior margin medially and an irregular spot behind each eye. Disc brownish with pale margins. Elytra with basal portions white, a fuscous spot on disc of each clavus and three fuscous spots on each costal margin. Veins pale, margined with fuscous, Face pale with three transverse black bands, one across apex of clypeus. one below the antennae and one below the margin of the vertex.

Genitalia: Last ventral segment of female truncate with a broad, blunt median tooth. Male plates elongate, triangular, rather broad basally, tapering to narrow blunt tips. Style rather broad, notched on outer margin at about one-third the distance from the apex, the sides of apical third parallel, the apex blunt. Aedeagus long and narrow, the apex bent slightly dorsally, broadened just before apex and tapered to a sharp pointed tip.

This species occurs on cane, *Arundinaria tecta*, along the southern Atlantic coast from Virginia to South Carolina.

Sanctanus limicolus (Osborn)

Deltocephalus limicolus Osborn. Fla. Ent. 6: 17, 1922.

A dark gray species with fuscous markings. Length 3.5–3.75 mm.

Vertex obtusely angled, about one-half longer at middle than next the eyes. The clavus with numerous reticulations and the anteapical cells broken by irregular cross veins.

Color: Vertex white with four fuscous dots on the anterior border, two lunate spots midway and two rounded ocellate spots on the hind border. Pronotum fuscous with five gray longitudinal stripes. Scutellum with ivory spots each side. Elytra with areoles mostly fuscous and veinlets mostly ivory white. The first apical areole black. Face pale fuscous with transverse whitish arcs.

Genitalia: Female last ventral segment with posterior margin almost truncate. Portions of the preceding segment conspicuous at the lateral margin. Male plates broad at base, rapidly narrowed to acutely upturned apices. Style rather short, slightly notched on outer margin about one-fifth the distance from apex, the apical fifth thick and blunt at tip. Aedeagus long and narrow in lateral view. In ventral view appearing bifid on apical third, the apical processes forming long, tapering, pointed apices.

This is a common tidal flat species of the Florida coast.

Sanctanus eburneus (DeLong)

Deltocephalus eburneus DeLong. Jour. N. Y. Ent. Soc. 32: 63, 1924.

A white species with few and faint markings, apparently related to *sanctus*. Length ♀, 4.5 mm.

Vertex bluntly angled, almost one-fourth wider between eyes at base than length at middle. Disc flat, rather sharply angled with front. Pronotum almost twice as broad as long. Clavus of elytra reticulate, central anteapical cell long, constricted and divided at center.

Color: Vertex white with four small pale orange spots above margin and a pale blotch on disc either side of middle. Pronotum with a broad median brownish stripe and a narrower one either side. Scutellum pale yellow with basal angles and apex darker. Elytra milky white, a large spot on middle of outer clavus dark brown, posterior claval cells washed with yellow. Inner anteapical cell, anterior and posterior portions of middle anteapical cell and outer apical cell pale to dark brown. Face, clypeus and lorae heavily embrowned with traces of pale arcs on face.

Genitalia: Female last ventral segment with posterior margin shallowly, concavely rounded.

This species was described from Mississippi, and no other records have been published to date.

Sanctanus fusconotatus (Osborn)

Deltocephalus fusconotatus Osborn. Fla. Ent. 6: 17, 1922.

White, marked with fuscous spots on pronotum, scutellum and base of elytra. Length, male, 3.5 mm.

Vertex bluntly angled, as long at middle as width between the eyes at base.

Color: White, vertex bordered anteriorly with black, except at apex, the outer part of the black line enclosing the ocelli. Pronotum with three diffuse spots, scutellum with two dots on the base. Each elytron has a small fuscous basal spot and a spot just before and just behind the merged veins. A dark spot on costa near base and another before the apical cells. Face densely black at base, clypeus and lower portion of face white.

Genitalia: Male plates small, triangular, about one-half the length of the pygofer. The styles are rather broad at the base, abruptly narrowed near the apex and produced in narrow fingerlike apices. The aedeagus in ventral view is inflated just before apex. In lateral view it appears narrow just before the apex and slightly broadened at the apex.

In type of genitalia it appears closely related to ***aestuarium***.

The species is known from the type specimen only, collected at Cameron, Louisiana.

Sanctanus aestuarium (DeLong and Sleesman)

Polyamia aestuarium DeLong and Sleesman. Anns. Ent. Soc. Amer. 22: 101, 1929.

Superficially resembling ***P. arundineus*** in general coloration. Apparently allied to ***limicolus***. Length 4 mm.

Vertex rather broad, produced, slightly wider between eyes than length at middle, flat or slightly depressed on disc. Central anteapical cell constricted and divided.

Color: Pale yellow, a pair of oblique orange bands extending from the margin of the vertex to the central posterior portion of the disc.

Pronotum with a large orange spot along anterior margin extending between the eyes, and a large round spot on central portion of pronotum behind either eye. Basal angles of scutellum orange. Elytra orange yellow, veins milk-white and heavily infuscated at certain places. A large spot on the costal margin at about its middle, discal, central anteapical and apical cells fuscous. Face black above, the coloration extending obliquely beneath the eyes.

Genitalia: Female last ventral segment rather short on lateral margins, then produced to form a broad trilobate posterior margin, only a slight notch occurs either side of central lobe, but the coloration causes it to appear decidedly trilobate. Lateral portions of underlying segment produced beyond last ventral segment at either side. Male plates short, strongly convexly rounded to pointed apices. Style elongate, rather deeply notched on outer margin near apex, the apical fifth narrow, finger-like, tip rather sharply angled. Aedeagus in lateral view bulbous at base, strongly narrowed then slightly enlarged at apex. In ventral view it is narrowed on basal half, the apical half convexly rounded and broadened, then narrowed to narrow blunt apex.

This species occurs in the tidal salt marsh of the lower Atlantic coastal area. It was originally described from North Carolina.

Sanctanus fasciatus (Osborn)

Scaphoideus fasciatus Osborn. Jl. Cinc. Soc. Nat. Hist. 19: 190, 1900.

A broad-headed species with a blunt vertex. Length 4 mm.

Vertex about one-third wider between eyes at base than median length, anterior margin produced and rounded.

Color: Vertex pale with two dark points just above apex and two paler transverse spots between anterior margins of eyes. Face pale, two marginal bands just below margin, also two dark bands, one across face just beneath eyes and another across clypeus. Pronotum with a dark spot behind each eye on anterior margin. Scutellum pale with a dark spot in each basal angle. Elytra when closed in normal position with a brown cruciate band extending from anterior costal margin to and along commissure to apex. The outer margin is bordered with dark brown. The white base of the clavus parallels the edge of the scutellum, and a white bar crosses the clavus obliquely near the tip.

Genitalia: Female last ventral segment concavely excavated. Male plates broader than long, broadly rounded, reaching to about the same length as the apex of styles. The apical half of the style is narrowed, produced and tapered to a blunt apex. The aedeagus in lateral view is narrowed on the apical fourth to form a slender apex. There is a broad shallow excavation on the dorsal margin. In ventral view the aedeagus is deeply roundedly notched at the apex, forming a pair of separated apical teeth.

This species was originally described from specimens collected at Port au Prince, Haiti, and Frontera, Mexico. It is apparently a rather common species in Mexico and has been collected at Valles, S. L. P., September 25, 1941; Tehuantepec, Oax., October 13, 1941, and Iguala, Gro., September 11, 1939, by Plummer, Caldwell, Good and DeLong.

Sanctanus marginellus n. sp.

A rather broad-headed species with blunt vertex resembling *fasciatus*, but elytra with a more general brownish color. Length 4 mm.

Vertex about one-third wider between eyes at base than median length, anterior margin produced and rounded.

Color: Creamy white, vertex with a brown spot above ocellus next each eye and two elongated dark brown spots almost contiguous extending from ocellus almost to apex just above margin. There is paler brown mottling either side of a median paler stripe. Pronotum pale brown with irregular white spots along anterior margin behind each eye. Scutellum dull brown. Elytra pale brown, subhyaline, with dark and pale areas similar to *fasciatus*. The markings are not intensified and blend more nearly with the coloration of the elytron. Face pale with the transverse band between the antennal pits and two conspicuous transverse bands beneath the margin of vertex.

Genitalia: Female last ventral segment rather shallowly concavely excavated between produced lateral angles and either side of a short blunt median tooth. Male plates broader than long, broadly rounded, about as long as apices of styles. Style with apical half narrowed, produced, tapered to a blunt apex. Aedeagus in lateral view narrowed to form a slender apex on apical fourth. There is a broad shallow excavation near base on dorsal margin with a short basal spur extending dorsally. In ventral view the aedeagus is deeply roundedly notched at apex forming a pair of separated apical teeth.

Holotype male, *allotype* female and female *paratypes* collected at Cantetul, Guat., December 11, 1925, (M. F. 878), by Dr. Dampf.

Sanctanus cruciatus (Osborn)

Scaphoideus cruciatus Osb. Ohio Nat. 11: 253, 1914.

Resembling *fasciatus* in general appearance but with the vertex a little more produced and male plates more triangular in shape. Length 4.5 mm.

Vertex broadly, bluntly produced, more than one-third wider between eyes at base than median length.

Color: White, tinted with yellow. The vertex has two transverse brown spots just in front of the middle, with two minute black spots close to the eyes at base. Face with a distinct bar from lower border of eyes crossing below the antennae and a broader black band across the clypeus, enclosing lower half of the lorae and apex of clypeus. Elytra bearing the usual cruciate brown mark which is distinctly dark margined. Anteapical cells brown, bordered with black, their veins white. First and second anteapical cells usually black, third usually light, veins white.

Genitalia: Female last ventral segment with posterior margin concavely roundedly produced to form a rather broad rounded median tooth. Margin narrowly embrowned. Male plates broad at base, convexly rounded to rather blunt apices. Style rather broad at base, abruptly narrowed at about middle to form a long slender finger-like apical portion which is narrowed and blunt at apex. Aedeagus in ventral view rather narrow at base then broadened to form a tooth on each outer

margin from which the aedeagus is tapered to a pointed apex either side of a rather deep median incision. In lateral view it bears a dorsal spur near base and a conspicuous notch on dorsal margin just before middle.

The species was described from a specimen collected at Cold Springs Harbor, Long Island, N. Y. It has since been collected farther south along the Atlantic coast.

Sanctanus dampfi n. sp.

Resembling *fasciatus* in coloration and general appearance but with male plates more narrowed and elongated, apices greatly exceeding styles. Length 4.5 to 5 mm.

Vertex bluntly produced, rounded at apex, about one-third wider between eyes at base than median length.

Color: Vertex white, with two small brown proximal dots near apex and two transverse fuscous spots halfway between base and apex. Face pale with two brownish transverse bands just beneath vertex margin and a conspicuous band between the antennal pits. Pronotum pale with brownish mottling. Scutellum white, basal angles dark. Elytra with the fuscous cruciate mark across clavus, the posterior bars extend only to the middle of the disc. A fuscous band extends from this point to suture at apex of clavus. The cross is bordered with dark fuscous. A white band crosses the clavus obliquely near tip and the hyaline discal and apical spots are bordered with white.

Genitalia: Female last ventral segment concavely excavated with a slightly produced portion at apex. Male plates about one-fourth longer than basal width, broadly rounded at apex, decidedly longer than style. The style is broad basally, the apical half is narrow and sharp pointed apically. The aedeagus in lateral view is gradually narrowed to apical fourth which is slender. In ventral view the apex is rather deeply, roundedly notched forming a pair of separated, pointed, apical teeth.

Holotype male collected at Chiapa de Corza, Chiapas, July 26, 1926 (M. F. 1047). *Allotype* female taken at Reforma, Tab., June 21, 1938 (M. F. 6674). *Paratype* males from Pocviene, Tab., December 31, 1938 (M. F. 8215), and at Zapota, Tab., July, 1938 (M. F. 6859), all collected by Dr. Dampf.

Sanctanus sonorus n. sp.

Resembling *cruciatus* in general appearance but with vertex more strongly produced and with male genitalia distinct. Length 4.5 mm.

Vertex strongly produced, about one-fifth wider between eyes than median length, bluntly angled at apex, tip rounded.

Color: Vertex white with faint markings consisting of a proximal pair of faint brown points at apex and two faint brown transverse spots between the anterior margins of the eyes. Pronotum white, the posterior discal portion darker. A small brown spot just back of each eye on anterior margin. Scutellum white with brown spots in basal angles. Elytra pale with a brown cruciate mark resembling that of *fasciatus*, the posterior brown bars extend only to the disc, and the brown band extends to the suture at apex of clavus. A parallel band of white extends

along scutellum on base of elytron. The anterior apical cells are dark brown, the posterior apical cells are white, bordered with brown.

Genitalia: Female last ventral segment broadly shallowly excavated with a slightly produced, blunt tooth at middle. Male plates a little longer than basal width, broadly convexly rounded on outer margins to inner margin which is straight. Styles broad basally, tapered to pointed apices. Aedeagus broadly shallowly excavated on dorsal margin with a basal dorsally directed spur, aedeagus gradually tapered to a narrow apex. In ventral view the apex is rather deeply roundedly notched, forming a pair of separated pointed apical teeth.

Holotype male, *allotype* female and male and female *paratypes* collected at Mainari, Son., August 11, 1927 (M. F. 1282A). *Paratype* males and females collected at Yaqui Valley, Sonora, August 16, 1927 (M. F. 1285), and at Cuautla, Mor., August 27, 1937 (M. F. 6247). All material was collected by Dr. Alphonse Dampf.

Sanctanus virgatus n. sp.

In general form resembling *fasciatus* but with distinct coloration in the form of transverse bands on the vertex and pronotum and longitudinal stripes on the elytra. Length 4.5 mm.

Vertex broad, blunt at apex, scarcely angled, almost one-third wider between eyes than median length. Elytra long.

Color: Vertex with a pair of minute separated brown spots just back of apex, an oblique line just above each ocellus on margin, a broad transverse band on median half before anterior margins of eyes and a rather broad transverse band just before basal margin. Pronotum with two broad transverse brown bands, one just back of anterior margin and another just before posterior margin. A large brown triangular spot on each basal angle. Elytra dark brown to black with the veins rather broadly white, giving a striped appearance. There is a conspicuous white curved area on the corium and a curved oblique band extending from apex of clavus to costal margin. The posterior third of the elytron is pale brown to white with the veins rather heavily dark margined. Face with a broad black transverse band just beneath antennae and ventral margins of the eyes. A series of fused black arcs form a second transverse band between the eyes and a third narrow black band is just beneath the ocelli and beneath the margin of vertex.

Genitalia: Female last ventral segment produced from lateral margins to a truncate apex with a short median produced embrowned tooth. Portions of the underlying segment are visible at either side.

Holotype female collected at Tehuantepec, Oax., October 13, 1941, by Good, Plummer, Caldwell and DeLong. Female *paratypes* were collected at Piedras Negras, Vera Cruz, September 17, 1926, by Dr. Dampf (M. F. 1077).

PARASITIZATION OF THE ORIENTAL MOTH (CNIDOCAMPA FLAVESCENS (WALK.)) BY CHAETEXORISTA JAVANA B. AND B.

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During 1929 and 1930 the larvivorid (tachinid) fly *Chaetexorista iavana* B. and B. was successfully introduced from Japan into the United States as a parasite of the oriental moth (*Cnidocampa flavescens* (Walk.)). The oriental moth has a very restricted distribution in this country, occurring, so far as is known, only in the vicinity of Boston, Mass. Because of the restricted range of the host and the fact that attack by other parasites is practically negligible, it has been possible to follow the history of the parasite in its new environment more closely than is usually the case with an introduced species. This paper is a record of the proportion of host larvae parasitized from 1930 through 1942, with some observations regarding the factors responsible for fluctuations in percentage of parasitization.

HISTORY, DISPERSION AND HABITS OF THE ORIENTAL MOTH IN THE UNITED STATES

The early history of the oriental moth in the United States may be briefly summarized from publications by Fernald (6,) (7). The insect was first observed in the Dorchester section of Boston, Mass., in 1906. Since it is an oriental species prevalent in Japan, the proximity of the place of discovery to a former nursery which handled Japanese plants suggests that it probably was imported on nursery stock. Although the insect was abundant at the apparent center of distribution, only about 3 square miles were determined as infested in 1906. In 1916 about 12 square miles were known to be infested. The limits of dispersion in 1942 are shown in figure 1. Approximately 300 square miles are included in the infested area.

Larvae of the oriental moth feed on the foliage of a wide variety of trees. Norway maple is preferred, but pear, apple, cherry, plum, black birch, and sycamore maple are often fed on extensively. The larvae may also develop on a number of other plants. Infested trees are only slightly injured, for defoliation does not usually occur before

[1]This study was conducted at New Haven, Conn., under the direction of R. C. Brown. A number of workers have been engaged on different phases of the problem. P. A. Berry collected cocoons and made dissections at Melrose Highlands, Mass., and New Haven, Conn., from 1932 through 1937. J. V. Schaffner, Jr., and C. L. Griswold made many observations on the life history of *Cnidocampa*, and R. T. Webber made many of the early dissections at Melrose Highlands. Since 1937 the Massachusetts Department of Conservation, particularly through the work of M. H. Donovan, has collected a number of the cocoons. F. M. Wadley, of the Bureau of Entomology and Plant Quarantine, gave helpful advice on the statistical phases of the problem.

late in September. Nevertheless, the larvae are a considerable nuisance, because their spines cause a nettlelike poisoning or irritation when they come in contact with a person's skin.

The moth completes one generation each year. It spends the winter as a prepupa within a hard-shelled, oval cocoon, which is firmly attached to a twig or branch of its food plant. Pupation takes place about the first of May, and adult moths are present in the field from the latter part of June until late in July. The moths are nocturnal in

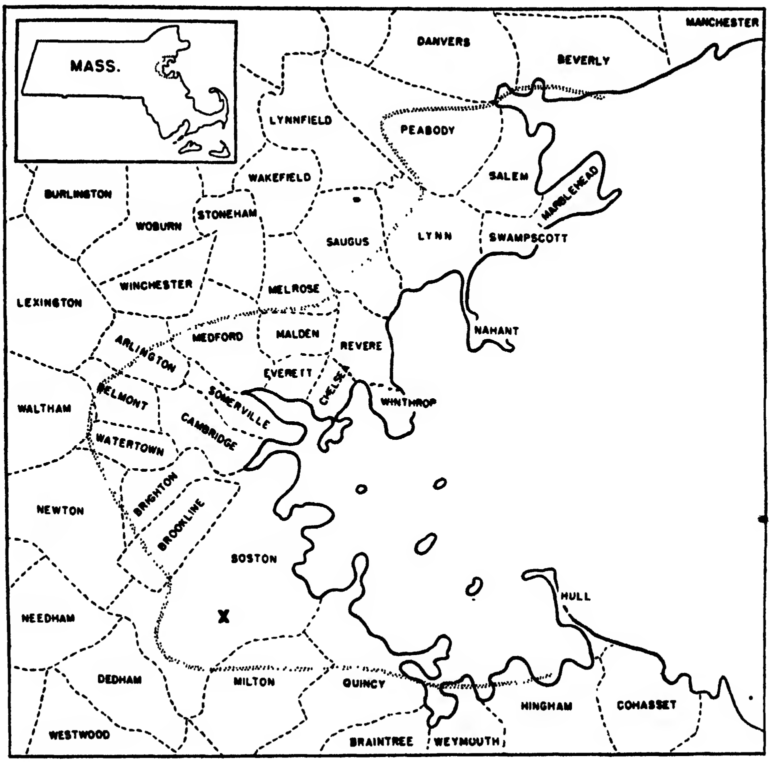

FIGURE 1. Map of Boston, Mass., and vicinity, showing known distribution of *Cnidocampa flavescens* (Walk.) (enclosed by double dotted line) in the United States. The point of original discovery at Dorchester in 1906 is indicated by X. Insert, the State of Massachusetts showing the relative size of the infested area.

habit, and apparently fly no great distance. The eggs hatch in about a week. The larvae, like other Limacodidae, are sluglike, slow-moving caterpillars and seldom wander far from their original food plant. Some larvae become full fed and spin their cocoons as early as August, but the greater number spin them late in September.

Cnidocampa flavescens is widely distributed in the Orient, having

been found from about the 50th parallel in southern Siberia to the 30th parallel somewhat south of Shanghai, in China. A comparable area in North America would include southern Canada and all of the United States except the southern parts of Florida and Texas.

Dispersion of the moth in the United States has been surprisingly slow. The rather sedentary habits of both moths and larvae only partially explain why this species has not become more widespread. Certainly its ability to develop on a great variety of common food plants and its tolerance to wide variations in climate, as evidenced by its distribution in the Orient, would indicate a potential distribution far in excess of the maximum distance of 25 to 30 miles which it has spread during the 40 years that it is known to have been present in this country. Dyar (5) even made an attempt, fortunately unsuccessful, to establish the species in Washington, D. C. Even if this insect becomes far more widespread in the future, its originally slow dispersion must rank as one more of the unpredictable features of insect behavior with which the entomologist is continually confronted.

INTRODUCTION AND ESTABLISHMENT OF CHAETEXORISTA JAVANA

The introduction and establishment of *Chaetexorista javana* in this country and the rapidity with which the species subsequently parasitized a large proportion of the host population has been well summarized by Collins (3). In 1928 arrangements were made with T. R. Gardner, of the Bureau of Entomology, then engaged in the collection of Japanese beetle (*Popillia japonica* (Newm.)) parasites in Japan, to ship overwintering cocoons of *Cnidocampa flavescens* to the forest-insect laboratory at Melrose Highlands, Mass. About 30,000 cocoons were shipped to this country in the spring of 1929 and about 779,000 in 1930. The entire 1929 shipment and 485,000 cocoons of those obtained in 1930 were collected at Fuji, Japan, and the remainder were collected at Aikawa, Japan. The material in these shipments produced a total of 6,190 *Chaetexorista* adults in 1929 and 86,711 in 1930.

The rather simple life history of the parasite made its importation a comparatively easy problem. *Chaetexorista javana* is a large larvivorid fly, which completes a single generation each year. It overwinters as a second-instar larva within the hibernating *Cnidocampa* prepupa. Development is completed early in the summer, and the puparium is formed within the host cocoon. The adult parasite emerges by pushing off the cap at the end of the host cocoon, which normally serves as an exit for the adult moth. The female fly deposits a large egg on the integument of the host larva. Upon hatching the young maggot bores into the body of the larva, attaching itself by means of an integumental funnel. Only one parasite develops to maturity in a host larva.

At the Melrose Highlands laboratory the *Cnidocampa* cocoons were held in cardboard boxes. Separation of the emerging moths and flies was facilitated by the fact that the moths normally emerge at night and the flies during the daytime. The flies, as they emerged, were put in large cloth-covered cages for transportation to the 16 liberation points scattered throughout the infested area.

RECORD OF PARASITIZATION IN THE UNITED STATES

An attempt to collect oriental moth cocoons was made every year from 1930 through 1942, except in 1935, at each of the 16 original *Chaetexorista* liberation points. When practicable, 200 cocoons were collected at a point. Frequently none and often considerably fewer than 200 cocoons were obtained. In Quincy and at 2 points in the southern and western outskirts of Boston (Neponset and Jamaica Plain) no cocoons could be found after 1932. At 4 other points (South Boston, Dorchester (at Pope's Hill), Saugus, and Everett) collections have been small and intermittent. It has been possible, however, to get the full 200 cocoons almost every year at the other 9 points (Dorchester (at Columbia Road,) Cambridge, Medford, Chelsea, Winthrop, Nahant, and 3 points in Revere), and 83 per cent of the total of 18,033 cocoons were obtained at these 9 points. All the cocoons were opened at the laboratory, and the prepupae were dissected to determine whether or not they were parasitized.

Figure 2 shows the percentage of parasitization of all cocoons collected each year. These figures approximate closely those for the 9 points where most of the cocoons were collected. The largest proportion of cocoons were parasitized in 1933, when 63.5 per cent contained *Chaetexorista* larvae. This figure was nearly equaled in 1940, when 58.9 per cent were parasitized.

The significance of the variation in percentage of parasitization at the 9 collection points, where most of the cocoons were collected, was determined by an analysis of variance of data obtained during the 11-year period 1930–40. No collections were made in 1935, and at several points no collections were made in 1941; so these 2 years were omitted from the calculations. The analysis showed significant, but not highly significant, variation between percentages of parasitization at the collection points. Further analysis showed that the significant variation was due to data from 3 points, namely, Cambridge, Nahant, and one point in Revere. The average percentage of parasitization for these three points was 27.76, whereas for the other six points it was 37.73 Reasons for the variation indicated are too difficult to interpret with the limited knowledge available. There certainly seem to be no geographical or ecological differences between these points and the others. Nahant might be considered somewhat removed, but the three collection points in Revere are hardly 2 miles apart, and there seems to be no apparent reason why one should vary significantly from the other. From a practical standpoint it is probably advisable to think of *Chaetexorista* as destroying about the same proportion of its host population throughout the entire area represented by the 9 collection points.

In addition to the cocoons collected at the original *Chaetexorista* liberation points, a number of collections made by the Massachusetts Department of Conservation were also dissected. In 1939 a total of 2,490 cocoons from 31 collection points proved to be 19.9 per cent parasitized by *Chaetexorista*. The next season 2,043 cocoons were collected, principally from 2 localities. Of these, 39.9 per cent were parasitized. There were 2,893 cocoons collected at 6 points in 1941, and

57.5 per cent were parasitized. These figures are interesting when compared with the parasitization at the *Chaetexorista* liberation points, which were 52.4, 58.9, and 53.9 per cent in 1939, 1940, and 1941, respectively. Two possible explanations for the lower figures of the Conservation Department collections in 1939 and 1940 seem worth considering. In the first place most of these collections were made on the outskirts of the infested area, where it is probable that *Chaetexorista* had not been of general occurrence over a long period; and secondly, many of the collections were made in what appeared to be rather sudden, heavy outbreaks of *Cnidocampa*. In general, the lighter infestations in 1939 had a larger proportion of parasitized cocoons.

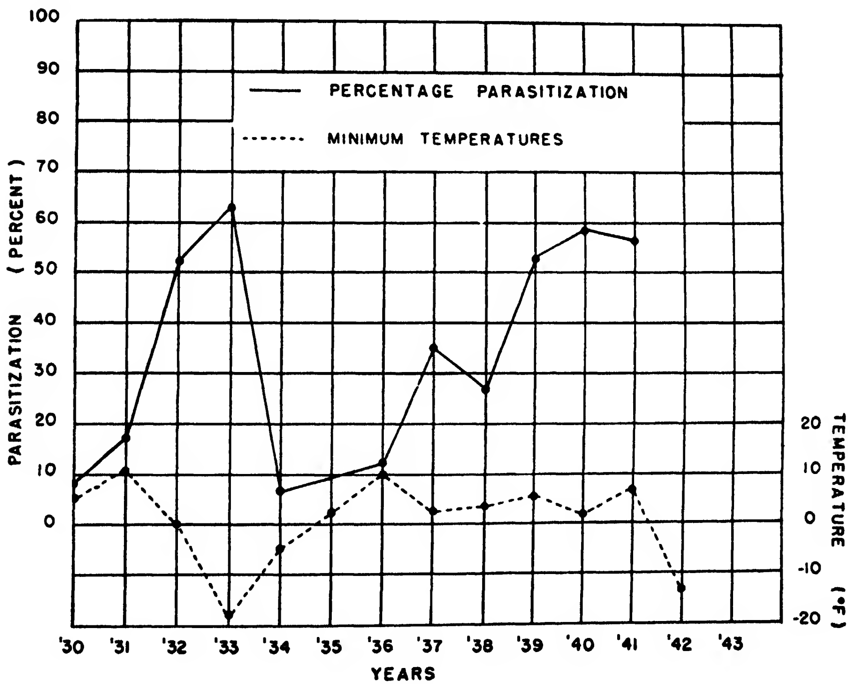

FIGURE 2. Combined percentage of parasitization of prepupae of *Cnidocampa flavescens* in 16 collection points by *Chaetexorista javana* during the years 1930–41, and minimum official temperatures recorded at Boston, Mass., 1930–42. (The minimum temperature noted for any year actually refers to the winter beginning in that year, as 1930–31.)

EFFECT OF SUBZERO TEMPERATURES ON CHAETEXORISTA AND CNIDOCAMPA

Figure 2, showing the parasitization at the *Chaetexorista* liberation points, also shows the minimum official temperatures recorded at Boston, Mass. As with the insect records, the minimum temperature for any year actually refers to the winter beginning in that year, for example, the winter of 1930–31. The minimum temperature has been

recorded in this manner to correspond with the year the *Cnidocampa* cocoons were formed and parasitization by *Chaetexorista* took place. The very sudden drop in parasitization in 1934 was undoubtedly caused by the exceptionally low temperatures in the winter of 1933. In fact, all parasitized prepupae dissected in the spring of 1934 contained dead *Chaetexorista* larvae.[2] Of course, some *Chaetexorista* larvae survived; otherwise the species would not have been capable of parasitizing 11.4 per cent of the cocoons collected in 1936. Nevertheless, the killing was so widespread that no survivors were observed in material dissected that spring. Through a succession of comparatively mild winters, following 1934, the proportion of cocoons parasitized by *Chaetexorista* increased rather rapidly until 1940, when it was almost 60 per cent. The winter of 1942, however, was exceptionally cold, and a minimum temperature of —14° F. was recorded at Boston. About 200 cocoons each were collected at Cambridge, Chelsea, and one point in Revere in the spring of 1943. Dissections showed 369 hibernating second-instar *Chaetexorista* in the 601 prepupae examined, and all the parasites were dead. Another sharp drop in parasitization was therefore expected in 1943.

A considerable amount of experimentation was conducted under laboratory conditions to determine what temperatures were lethal to the hibernating parasites. Small lots of *Cnidocampa* cocoons, some of which had been conditioned by outdoor temperatures, were exposed to 0°, —5°, and —10° F. for 24 hours.[3] Temperatures of 0° did not affect the hibernating *Chaetexorista* larvae, whereas −5° killed about 80 percent and —10° killed all of them. One lot of cocoons was also exposed outdoors to a short, sudden drop in temperature to —6°. About half the parasites were killed. Check lots of cocoons held in the laboratory all winter at 36° consistently showed no mortality of hibernating parasites when dissected in May, and check lots brought in from the field at various times in the winter and held at 36° until dissected in May consistently showed no increase in *Chaetexorista* mortality after the cocoons were brought into the laboratory.

There is no doubt that temperatures between 0° and —5° F. kill a high percentage of *Chaetexorista* larvae. It is not so clear, however, whether or not higher temperatures under certain conditions, or other unknown factors, may kill them. Records from field-collected cocoons formed in 1938, 1939, 1940, and 1941 showed high mortality of *Chaetexorista* larvae, and yet the official minimum temperature recorded in Boston for these four winters was 2°. The most complete records for any one year were those obtained for cocoons formed in 1941. These cocoons were collected by the Massachusetts Department of Conserva-

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[2]Throughout this discussion reference to dead *Chaetexorista* larvae refers only to dead second-instar maggots. Although several *Chaetexorista* larvae may enter a *Cnidocampa* larva, only one can complete its development, and seldom does more than one reach the second instar, or hibernating stage.

[3]Experiments to determine the effects of exposure to cold were carried on at the Connecticut Agricultural Experiment Station through the courtesy and help of Raimon L. Beard. Cocoons were collected at different times during the winter and exposed in lots of 50 for 24 hours. A thermocouple was inserted inside one cocoon in each lot; therefore, the temperatures referred to actually represent the temperature inside the cocoons.

tion on three different dates at approximately the same locations in Beverly, Revere, Salem, and Winthrop. That winter a minimum official temperature of 7° was recorded in Boston on December 21. Nevertheless, collections in April showed that 90 per cent of the *Chaetexorista* larvae were dead. The data on these dissections are summarized in Table I.

TABLE I

MORTALITY OF HIBERNATING *Chaetexorista javana* DURING THE WINTER OF 1941–42 IN THE VICINITY OF BOSTON, MASS.

Date of Collection	Month of Dissection	Living Prepupae Containing			Parasitization	Parasites Present	
		No Parasites	Living Parasites	Dead Parasites		Living	Dead
		Number	*Number*	*Number*	*Percent*	*Percent*	*Percent*
BEVERLY							
Nov. 28	Nov.	83	17	0	17.0	100	0
	May[1]	20	4	0	16.7	100	0
Jan. 20	Jan.	68	8	21	29.9	27.6	72.4
	May[1]	75	9	15	24.2	37.5	62.5
April 7	April	71	0	20	22.0	0	100
REVERE							
Nov. 27	Nov.	78	20	2	22.0	90.9	9.1
	May[1]	24	6	0	20.0	100	0
Jan 19	Jan.	60	18	10	31.8	64.3	35.7
April 7	April	67	2	11	16.2	15.4	84.6
SALEM							
Dec. 1	Dec.	89	11	0	11.0	100	0
	May[1]	31	7	1	20.5	87.5	12.5
Jan. 21	Jan.	68	2	19	23.6	9.5	90.5
Feb. 9	Feb.	64	1	26	29.7	3.7	96.3
April 7	April	73	2	18	21.5	10.0	90.0
WINTHROP							
Nov. 27	Nov.	85	13	1	14.1	92.9	7.1
	May[1]	31	5	0	13.9	100	0
Jan. 21	Jan.	68	11	6	20.0	64.7	35.3
	May[1]	85	6	5	11.5	54.5	45.5
April 7	April	67	3	12	18.3	20.0	80.0

[1]Held in the laboratory at 36° F. from the date of collection to date of dissection.

The data in Table I show clearly that the mortality of *Chaetexorista* increased at the collection points during the winter of 1941–42, but that no increase in mortality took place in cocoons brought into the laboratory in November and held at 36° F. until May. Since the minimum temperature for Boston that winter was 7°, it was apparent that higher temperatures than those required to kill *Chaetexorista* by short exposures in the laboratory may cause high mortality in the field. The sudden fluctuations or the longer duration of the higher outdoor temperatures

appeared to be responsible, but no laboratory experimentation along this line has been attempted. Some other factor may have been present, but survival of *Chaetexorista* in cocoons brought into the laboratory seemed to preclude this possibility.

Another possibility is that the official minimum temperatures recorded for Boston did not represent the actual minimum temperatures at the collection points, notwithstanding the close proximity of these points to the station. In order to check further, a maximum-minimum thermometer was set up at Revere, and minimum readings were compared with those taken at Boston from December 23, 1942, to March 15, 1943. Readings at Revere were consistently lower than those at Boston, but seldom were the two sets of readings more than 3° or 4° apart, and the minimum for the period of —14° was the same at both locations. The mean daily minimum for the period was 22.5° at Boston and 20.5° at Revere.

Somewhat confusing but nevertheless of considerable interest was the rather steady increase in the proportion of hibernating *Chaetexorista* larvae that died during the winters of 1939, 1940, and 1941. Collections of overwintering cocoons in each of these years in April at the 16 *Chaetexorista* liberation points were found to contain, respectively, the following number of parasitized prepupae: 1,077, 607, and 561. The proportions of dead *Chaetexorista* for the respective years were 22.5, 59.6, and 78.6 per cent. The same tendency was noted in collections made by the Massachusetts Department of Conservation at 4 points (Revere, Winthrop, Salem, and Beverly) in 1940 and 1941.

A *Cnidocampa* prepupa containing a hibernating *Chaetexorista* larva dies, whether the parasite lives or not. The hibernating parasite is a large maggot, and if it dies the host is incapable of sloughing it off and transforming to the adult stage. In April, 1941, cocoons from four locations were separated into two lots—one lot of 463, the other of 464. The first lot was dissected, and the other was reared. The dissected lot had 198 parasite-free prepupae, 52 prepupae that contained living parasites, 184 prepupae that contained dead parasites, and 29 cocoons that had been formed in a previous season. The reared lot produced 196 moths and 52 adult parasites. An examination of the unemerged cocoons showed that 169 dead *Cnidocampa* contained dead *Chaetexorista*, 22 dead *Cnidocampa* had died from an undetermined cause, 6 *Cnidocampa* were still alive, and 19 cocoons had been formed in a previous season.

Overwintering *Cnidocampa* prepupae can withstand far lower temperatures than can the parasites. A good test of the cold-hardiness of *Cnidocampa* was provided during the winter of 1942–43, when official temperatures within a few feet of exposed cocoons went as low as —18° F. in December, —24° in February, and —6° in March. Adult emergence from unparasitized cocoons in three exposed lots comprising 410 cocoons was unaffected, but in parasitized cocoons all *Chaetexorista* maggots and *Cnidocampa* prepupae were killed. Lethal low temperatures for hibernating *Cnidocampa* have not been determined, but apparently they will survive any temperatures likely to be encountered in the vicinity of Boston.

RELATION BETWEEN OVIPOSITION OF CHAETEXORISTA AND PROPORTION OF CNIDOCAMPA PREPUPAE EFFECTIVELY PARASITIZED

Chaetexorista javana lays an external, macrotype egg. Upon hatching, the parasite larva bores through the skin of its host. The larva is fastened within the body cavity by an integumental funnel, which is usually formed some distance from the eggshell. Eggshells laid on the penultimate larval instar arc molted off with the larval skin. A large proportion of the eggs are deposited on full-grown larvae and undoubtedly some eggshells are rubbed off, but most of them remain attached to the skins of the prepupae.

It is a simple matter to record the number of shells present when dissections are made. Such a record was kept for 10,022 prepupae dissected from 65 collections of cocoons during 1939, 1940, and 1941. In these collections 4,606 *Cnidocampa* prepupae contained *Chaetexorista* larvae and all but 469 bore at least 1 eggshell. It is therefore believed that records made of the number of eggshells found on each prepupa offer valuable data regarding (1) the relation between the number of eggs laid and the proportion of prepupae parasitized; (2) the proportion of eggs that may be considered wasted, since only 1 parasite can develop per host larva; and (3) the searching ability and discriminatory powers of the adult female *Chaetexorista*, as indicated by the number and distribution of eggs deposited.

In calculating the relation between the number of eggs laid and the proportion of prepupae parasitized, it has been considered advisable to plot the percentage of parasitization for each collection of cocoons against the mean number of eggshells actually found on all the prepupae in that collection, including also in the number some prepupae that contained parasites but upon which no eggshells were found.

There was a highly significant correlation ($r = 0.84$) between the percentage of parasitization and the mean number of eggs deposited per host larva in the 65 collections. Variations in the mean number of eggs accounted for 70.56 per cent of the variation in perccntage of parasitization. This relationship is shown graphically in figure 3.

The curve is the graph of the regression ($E = 66.14 \log x + 41.14$) of the percentage of parasitization on the logarithm of the mean number of eggs in each collection. The curve has an error of estimate of 8.72 per cent. It shows clearly the rapid increase in the percentage of parasitization as the average number of eggs deposited per host larva increased. Approximately 41 per cent parasitization occurred when an average of 1 egg was deposited per host larva, and approximately 61, 73, and 81 per cent parasitization when averages of 2, 3, and 4 eggs, respectively, were deposited per host larva. A parasitization of 60 per cent, for instance, reflects a parasite population so high in relation to that of the host that the female parasites find at least 60 per cent of the host larvae and lay an average of 2 eggs per larva on the entire population.

It would seem that the parasite population would have to be relatively high to do this. In 1933 and again in 1940 and 1941 between 54 and 63 per cent of the prepupae at 16 *Chaetexorista* liberation points were parasitized. Unfortunately, low temperatures reduced the

Chaetexorista population to a very low level in 1934 and again in 1942. The writer doubts that, had low temperatures not interfered, much higher parasitization in 1935 and 1943 could have been expected over such a wide area unless some factor not affecting *Chaetexorista* greatly reduced the *Cnidocampa* population before the parasite eggs were

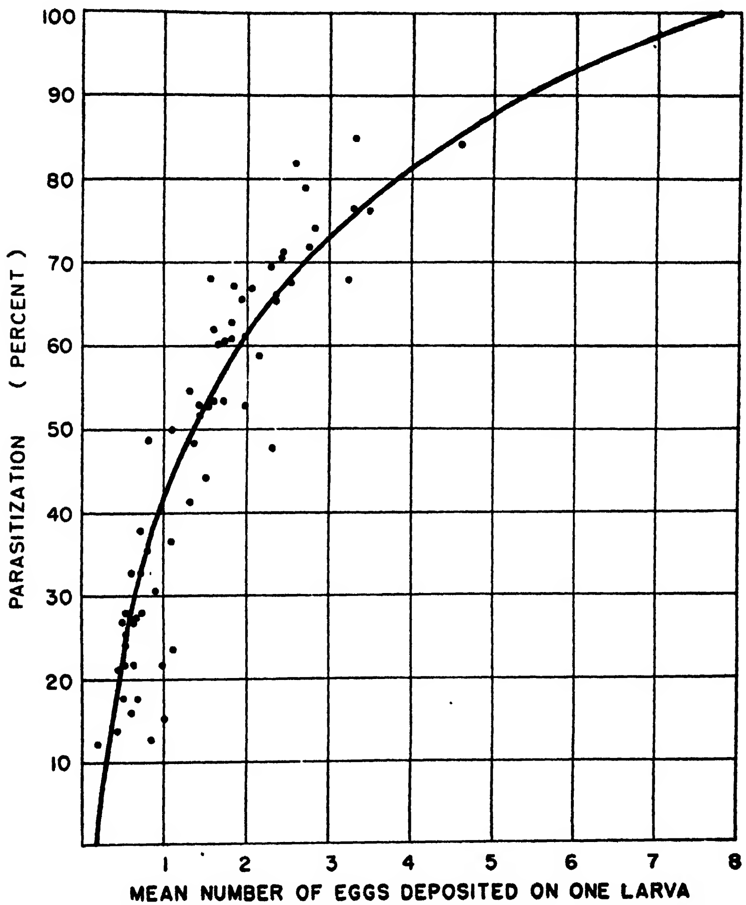

FIGURE 3. Correlation between the percentage of parasitization of *Cnidocampa* prepupae and the mean number of *Chaetexorista* eggs deposited on each host larva in 65 collections. Dots denote individual collections.

deposited. This opinion is substantiated, not only by the fact that the relative abundance of the parasite would have to increase rapidly as the parasitization increased above 60 per cent, but also, to a certain extent, by field observations. At 3 collection points, each of which is a small isolated area comprising less than an acre, the host population remained fairly constant from 1938 through 1941. Parasitization at

these points fluctuated between 51 and 69 per cent, but never went higher, although at 1 point it dropped to 39 per cent for 1 year.

Quantitative data regarding host density at these 3 collection points are lacking, but these figures seem to indicate that the proportion of hosts parasitized had approached a fixed rate in the manner described by De Bach and Smith (4) for ***Mormoniella vitripennis*** (Walk.) and ***Muscidifurax raptor*** Gir. The total parasitization at the 16 collection points in 1939, 1940, and 1941 also seems to offer some support for this belief, for parasitization was 52 per cent in 1939 and 59 per cent in 1940, but it dropped back to 54 per cent in 1941.

In 1932 sample lots of *Cnidocampa* cocoons imported from Japan were dissected. A total of 514 cocoons from Fuji proved to be 18.87 per cent parasitized. The prepupae bore a mean number of 0.31 *Chaetexorista* egg. Of 576 cocoons from Aikawa 20.31 per cent were parasitized, and the prepupae bore a mean number of 0.36 *Chaetexorista* egg. These percentages are similar and the mean numbers of eggs in the collections lie close to the curve shown in figure 3.

Calculations regarding the proportion of *Chaetexorista* eggs that may be considered as ineffective or wasted because they failed to produce a hibernating parasite larva were based on the fact that only 1 *Chaetexorista* can complete its development in a *Cnidocampa* prepupa. However, ineffectiveness is caused, not only by a duplication of egg deposition, but also by a natural mortality due to poor viability of eggs, improper placement on host integument, inability of the parasite larva to establish itself in its host, and other causes.

An estimate of natural mortality from all collections was obtained by determining from the prepupae that bore only 1 eggshell the proportion that failed to contain a hibernating *Chaetexorista* larva. For 1939 and 1940 this proportion was similar for all collections, averaging 26.6 ± 1.37 per cent. In 1941, however, this proportion was 53.8 ± 4.22 per cent. The reasons for such a wide difference are obscure. In 1941, of the 20 collections, 14 were made in 4 towns—Beverly, Salem, Revere, and Winthrop—and parasitization ran comparatively low, 13 to 27 per cent. Possibly some unknown climatic factor affected fertilization of the eggs that year. It seems probable that the natural mortality occurring in 1939 and 1940 represents the more normal field conditions.

Among the *Cnidocampa* prepupae that bore 1 or more *Chaetexorista* eggs, the percentages bearing 1, 2, 3, 4, 5, and more than 5 eggs were determined for each of the 65 collections. The regressions of the percentages bearing 1 egg, 2 eggs, etc., on percentages of parasitization were calculated in order to obtain an estimate of egg distribution at different levels of parasitization. Table II summarizes these data.

The data given in Table II indicate only slight variations in the proportion of larvae that bore 2 eggs between 25 and 85 per cent parasitization. They also indicate no more than slight variations in the proportion of larvae that bore 3, 4, or 5 eggs at the different levels of parasitization. There is thus a rather striking indication that eggs were deposited without discrimination as to whether or not a host larva already bore eggs. This was probably due in part to the more exposed position or the greater attractiveness of certain host larvae to the ovipositing parasites.

The data in Table II also indicate in a general way the proportion of eggs wasted by a duplication in egg deposition. Since the average number of eggs deposited increases with the percentage of parasitization, a correlation between the percentage of parasitization and the percentage of ineffective eggs is perhaps to be expected. When calculated for the 65 field collections, however, only a barely significant correlation (r=0.30) was found. Such a small correlation was without doubt due partly to the high incidence of natural mortality in the 1941 collections, for if data for 1941 are omitted the correlation between the two percentages is highly significant (r=0.72). Furthermore, the existence of an underlying correlation is clearly indicated if the prepupae from all collections that bore 1, 2, 3, 4, 5, and more than 5 eggs are tabulated separately, and the percentage of parasitization for each of these groups is determined. These percentages are, respectively, 62, 78, 87, 91, 93, and 97. Grouped in this manner the correlation coefficient for percentage of parasitization and percentage of ineffective eggs is high.

TABLE II

ESTIMATED PERCENTAGE OF PARASITIZED PREPUPAE OF *Cnidocampa flavescens* THAT BORE VARIOUS NUMBERS OF *Chaetexorista* EGGS AT DIFFERENT LEVELS OF PARASITIZATION IN 65 FIELD COLLECTIONS

Number of *Chaetexorista* Eggs Deposited per Host Prepupa	Errors of Estimate for Regression Lines	Percentage of Prepupae bearing *Chaetexorista* Eggs at Indicated Level of Parasitization						
		25%	30%	40%	50%	60%	75%	85%
1	13.4	56	53	47	41	35	26	20
2	7.7	27	26	25	24	23	21	20
3	8.4	12	13	14	15	16	17	18
4	3.6	4	5	6	7	9	11	12
5	2.5	1	2	3	4	5	6	7
5+	11.3	0	1	5	9	12	19	23

Summarizing all collections, there were 4,137 effectively parasitized host prepupae, which bore 11,908 eggs, or an average of 2.88 eggs per prepupa. Of the prepupae that bore eggs, 77 per cent were effectively parasitized; yet hibernating *Chaetexorista* that would have caused the death of the host developed from only 30 per cent of the eggs deposited.

Calculations regarding the number and distribution of eggs deposited on the prepupae in each collection provide data on the searching ability and discrimination of the adult female parasite. The expected distribution of eggs per host prepupa, had they been deposited as in a Poisson distribution, was worked out for each collection. From each of these distributions the expected percentage of larvae bearing eggs was computed and plotted against the mean number of eggs deposited on one host larva, as shown in figure 4, *A*. The dots represent the actual percentages. The log values of the actual percentages of larvae bearing no eggs for each collection were used in conjunction with the mean egg values in calculating the regression equation ($E = 1.932753 - 0.2431x$).

Expected log values were transformed back to percentages and their complements were plotted (fig. 4, *B*). The error of estimate in terms of logarithms is 0.1025. The curve for the percentage of parasitization as plotted in figure 3 (fig. 4, *C*) has been included here to emphasize the discrepancy between egg deposition and effectual parasitization. Curves *A* and *B* show that as the number of *Chaetexorista* eggs deposited on the host larvae increases there is less chance that the deposition of an additional egg will increase the proportion of host larvae parasitized. A comparison of curves *A* and *B* shows that *Chaetexorista* eggs are not distributed as they would have been had each host larva an equal

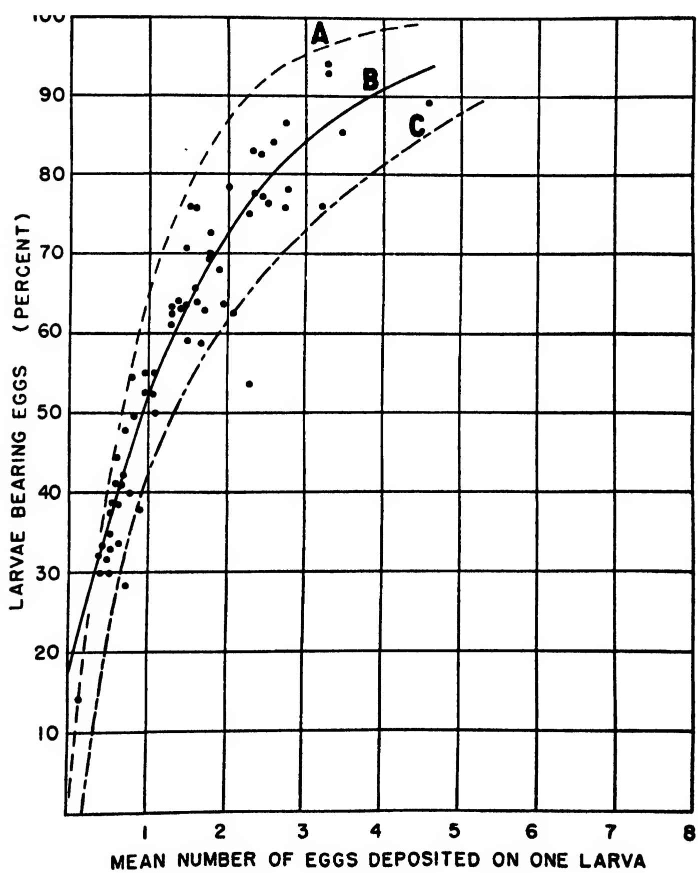

FIGURE 4. Correlation between the percentage of *Cnidocampa* larvae bearing eggs and the mean number of eggs deposited on host larvae in each collection: *A*, Curve showing percentage of larvae that would have borne eggs had they been deposited as in Poisson distribution; *B*, Curve fitted to percentage of larvae bearing eggs; *C*, Curve from figure 3 showing for comparison the correlation between the percentage of parasitization and the mean number of eggs deposited on the host larvae in each collection.

chance of being found and attacked, and therefore the percentage of host prepupae bearing eggs is smaller than it would have been had that been the case. The curves also show that there is an increase in the departure from random, or chance, distribution as the proportion of host prepupae bearing eggs increases from 30 to about 90 per cent of the prepupae in a collection.

A number of workers have studied the mathematical relation between entomophagous parasites and their hosts. In 1910 Fiske (8) worked out the probability of the occurrence of superparasitism, presenting a graph indicating the mathematical probability of an increase in percentage of parasitization with each additional egg deposited. In 1924 and 1929 Thompson (9) and (10) developed this conception further. He first showed that, if the eggs of a parasitic species are deposited at random, the expected parasitization may be expressed by the equation $y = N\left(1 - e^{\frac{x}{N}}\right)$, where N = total number of hosts, x = number of parasite eggs distributed, y = number of hosts parasitized, and $e = 2.71828$. Later he showed that when superparasitism occurs and only one parasite develops on a single host, if the reproductive rate of the parasite is greater than that of the host, superparasitism will not greatly retard the process of control in cases where control within a reasonable time would otherwise be probable.

Neither Fiske nor Thompson published any field data, but in 1933 Clausen, Jaynes, and Gardner (2), reporting on the parasitization of the Japanese beetle by the larvivorid fly *Centeter cinerea* Ald., used Fiske's curve and plotted counts of eggs deposited on beetles in 11 field collections containing from 200 to 1,000 beetles each. Their data show that *Centeter* eggs were distributed on fewer hosts than they would have been had each beetle had an equal chance of being attacked, and they conclude that this was because parasitized beetles are more sluggish than healthy ones. Studies by Beard (1) regarding parasitism of the squash bug (*Anasa tristis* DeG.) by the larvivorid *Trichopoda pennipes* F. indicate the same sort of a distribution of parasite eggs. Conclusions made in this study regarding egg deposition by *Chaetexorista* agree closely with those regarding egg deposition by *Centeter* and *Trichopoda*.

The results of all these studies emphasize the fact that the basis for observations regarding the dispersion of eggs by a female parasite must be the actual deposition of eggs, and not the number of hosts parasitized. They also emphasize that a comparison of an actual distribution with that in which each host has an equal chance of being attacked will not be satisfactory if the parasite has the ability to select unparasitized hosts for egg deposition. It is well known that some parasites have this ability to a considerable degree. Others, such as *Collyria calcitrator* Grav., studied by Walker (11), show a slight discriminatory power. Large groups of entomophagous parasites, however, do not appear to have this ability. The writer believes that the eggs of a parasite, that shows no ability to select unparasitized hosts for oviposition, will seldom be distributed among as many hosts as would be the case had each host an equal chance of being attacked. Probably the most important reason for this is the unequal exposure of the host population, although

undoubtedly the relation between actual and random distribution of eggs will vary greatly in different species.

EFFECT ON CNIDOCAMPA POPULATIONS OF PARASITIZATION BY CHAETEXORISTA

No quantitative data are available regarding *Cnidocampa* populations, either before or after the introduction of *Chaetexorista*. Certain generalizations are, nevertheless, of considerable interest. Since the larvae are easily killed by arsenical sprays, infestations on street trees are usually controlled. Those in back yards and on vacant lots, on the other hand, are likely to persist for a number of years.

The insect attracted little attention until about 1921, when considerable defoliation was observed throughout the Roxbury and Dorchester sections of Boston. Heavy infestations persisted throughout this area, spreading as far south as Quincy, until about 1929, when there was a noticeable decrease. Since then there has never been any appreciable feeding in that area. In 1923 some defoliation occurred north of Boston, at Winthrop, and, although only a few trees were involved, the number of defoliated areas increased rather steadily through 1932. At that time the insect was prevalent throughout Swampscott, Lynn, Nahant, Chelsea, Revere, Winthrop, Medford, and Cambridge. A marked decrease took place in 1933 and 1934, but in 1936 there was a decided increase which continued through 1938. Since that time light to medium infestations have persisted in small, isolated localities throughout much of the infested area north of Boston, notably in Cambridge, Chelsea, Revere, and Winthrop, and some severe defoliation has occurred in Salem and Beverly.

There is a temptation to ascribe the general decrease in *Cnidocampa* infestations north of Boston in 1933 and 1934 to the establishment of *Chaetexorista* in 1930, and the increase in infestations from 1936 through 1938 to the heavy parasite mortality during the winters of 1933 and 1934. In the opinion of the writer, *Chaetexorista* probably has played an important role in these fluctuations, but certain facts indicate that the parasite is by no means entirely responsible. In the first place, two areas in the southern part of Boston (Roxbury and Dorchester) that were kept under observation from 1922 to 1930 were defoliated every year until 1930, when there was a sharp decline. This was before the establishment of *Chaetexorista* could have affected the population of *Chidocampa*, and there has never been defoliation in these areas since that time. In the second place, heavy infestations in Swampscott and Nahant, which showed a sharp decline during 1933 and 1934, did not increase after 1936. Finally, severe defoliation occurred in Salem and Beverly for the first time after the cold winters of 1933 and 1934.

SUMMARY

The oriental moth (*Cnidocampa flavescens* (Walk.)), a native of eastern Asia, was discovered in this country at Dorchester, a part of Boston, Mass., in 1906. The area of infestation increased very slowly and in 1943 included only about 300 square miles in the environs of Boston. Oriental moth larvae feed on the foliage of a number of trees,

with Norway maple the preferred species, pear and cherry being among other trees attacked.

In 1929 and 1930 a larvivorid fly, *Chaetexorista javana* B. and B., parasitic on *Cnidocampa* in Asia, was shipped to this country from Japan. The parasite became established in this country almost immediately, and collections at the liberation points in 1933 indicated that it had parasitized more than 60 per cent of the oriental moth material collected. *Chaetexorista* overwinters as a second-instar larva within the hibernating prepupa of the host.

Temperatures between 0° and —5° F. kill a high proportion of the hibernating parasites, but temperatures at least as low as —24° do not affect the unparasitized host prepupae adversely. Parasitized host prepupae, however, are killed if the parasite dies. Minimum temperatures of —19° occurred in Boston in 1933, and the *Chaetexorista* population was reduced to a very low level. By 1942, however, it had increased to the point where 54 per cent of the prepupae collected at the liberation points were parasitized, but minimum temperatures of —14° that winter again severely reduced the parasite population. Considerable mortality of hibernating *Chaetexorista* larvae also occurred during winters when the official minimum temperature at Boston was several degrees above zero.

A comparison of the percentages of parasitization at 9 collection points over an 11-year period indicates that *Chaetexorista* is parasitizing about the same proportion of its host population throughout the whole area sampled.

There is a highly significant correlation between the mean number of *Chaetexorista* eggs deposited and the percentage of parasitization that may be shown by curvilinear regression. The female parasite deposits eggs on fewer host larvae than if the eggs were distributed at random, and as the percentage of parasitization increases from 30 to about 90 the departure from a random distribution increases. Only one *Chaetexorista* develops in a host. A large proportion of the eggs deposited are therefore ineffective, because they are laid on host larvae already bearing eggs. About 77 per cent of the larvae found bearing eggs were parasitized, but only 30 per cent of the eggs laid resulted in the death of a host.

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(10) ———. 1929. On the effect of random oviposition on the action of entomophagous parasites as agents of natural control. Parasitology 21: 180–188.
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INSETOS DO BRASIL, VOL. V, LEPIDOPTEROS, PART 1, by A. DA COSTA LIMA. 379 pages, 235 text figures. Escola Nacional de Agronomia, Serie Didatica No. 7, 1945.

The first part of this work covers the Jugate Lepidoptera and that part of the suborder Frenatae, division Heterocera, usually referred to as the Microlepidoptera. Since this is an inexact term, the superfamilies Incurvarioidea, Nepticuloidea, Cossoidea, Castnioidea, Zygaenoidea, Tineoidea, Tortricoidea and Pterophoroidea are covered.

The first 146 pages are about equally divided between an excellent discussion of the structure, metamorphosis and bionomics of the order and an extensive bibliography. The systematic portion includes a characterization of superfamilies and families but only occasional examples of included species, a necessary limitation for a work of its size. Under each category an artificial key to the included groups is supplied, down to the separation of families. Brief bibliographies are included.

The format is excellent and the printing and paper are good. Line cuts surpass the half-tones in quality, but most of the latter are good.

As a guide to an initial acquaintance with the classification of the microlepidoptera down to families the book appears to be thorough and excellent. Barring the fact that it is in Portuguese, it would be of wide value. The reviewer finds himself envying young lepidopterists of Brazil a clear approach which he lacked in his own early excursions in this field.—A. W. L.

MONOGRAPH OF THE FAMILY MORDELLIDAE (COLEOPTERA) OF NORTH AMERICA, NORTH OF MEXICO, by EMIL LILJEBLAD. Miscellaneous Publications, Museum of Zoology, University of Michigan, No. 62, 229 pages, VII plates. Ann Arbor, 1945. Price, $2.00.

To those who have known the quiet courtesy of Mr. Liljeblad through his many years of association with the Field Museum this publication will seem a fitting monument to his long devotion to a difficult family of inconspicuous beetles. The fact that the group is difficult for the ordinary taxonomist should guarantee the value of a revision by such a conscientious student. Certainly his knowledge must be the last word on the classification of the family for the present. The introduction bears further tribute to the care with which the study has been pursued, and the footnote on page ten stating that the manuscript was completed in 1929 and that the substitution of the generic name *Pentaria* for *Anthobates* is the only addition since that date, shows that the results were far from hastily presented.

The *Monograph* is beautifully printed. The seven plates are made up of skillfully executed drawings of structural details and of entire insects and are nicely reproduced. This publication should be essential to all libraries on the beetles.—A. W. L.

A NEW EUPHALERUS AND NOTES ON OTHER SPECIES OF PSYLLIDAE FROM IDAHO

(Homoptera: Psyllidae)

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Honolulu, T. H.

This paper presents the description of a new species of *Euphalerus* and some notes on the distribution, host plants and biology of several other species of Psyllidae collected in Idaho. In addition, the rearing of three genera of parasites from hackberry psyllids is reported. The opportunity of making most of these collections was afforded by the United States Bureau of Entomology and Plant Quarantine during the writer's service in the Division of Fruit Insect Investigations.

Euphalerus idahoensis n. sp.

(Figures 1, 1a and 2)

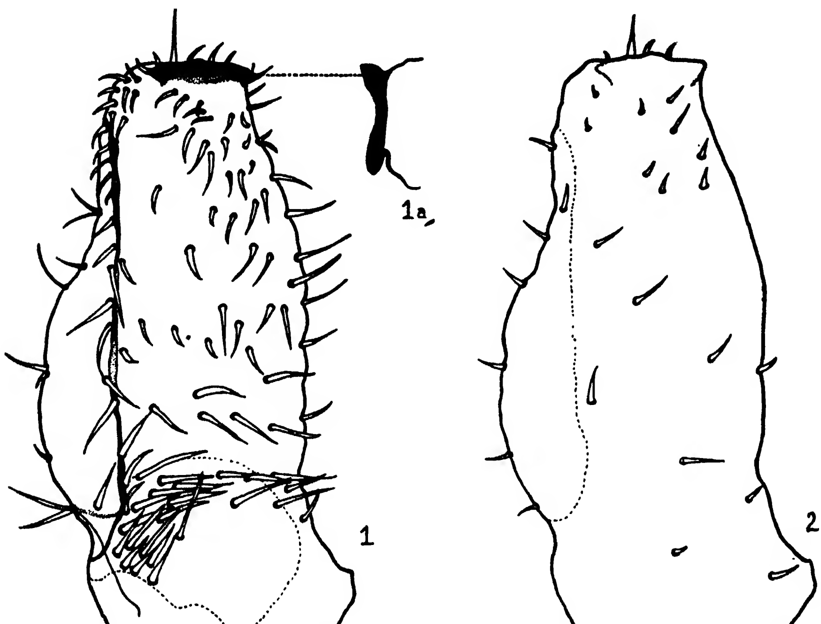
Color.—General color dark orange red with white and red vermiculations on vertex and thorax. Antennae black apically and on distal portion of other segments except basal three which are uniformly yellowish brown. Forewings subhyaline, amber colored. Abdomen of male pale orange to orange red; female abdomen usually greenish in life except for reddish genitalia.

Structure.—Length to tip of folded wings 3.5–4.0 mm. Length of body 3.1–3.7 mm. Length of forewing 2.7–3.0 mm. Width of head 0.90–0.96 mm. Length of antennae 1.5–1.7 mm. Length of vertex at median suture 0.28 mm. Width of thorax 0.9–1.0 mm. *Head* only slightly deflexed, produced almost horizontally in life (usually appearing strongly deflexed on dry specimens). Vertex flattened but bearing a distinct, though shallow, discal fovea on each side of median suture; beset with short, white capitate hairs. Genae produced on same plane as vertex, large, conical in form, equal in length to vertex, contiguous basally but divergent distally, tapering evenly to subacute apices, beset with conspicuous white pubescence. Antennae 1½ times as long as width of head.

Forewings rugose, about twice as long as broad, apical margin broadly rounded; pterostigma short but broad; marginal cells subequal in size, each bearing an inconspicuous alar radula extending in from margin; a third such radular area between the marginal cells. Posterior tibiae with three large black spurs on inside and one on outside of apex.

Genitalia.—Male: Proctiger 0.40 mm. long, appearing straight on dry specimens, but seen to curve sharply cephalad at base when entire structure is revealed by dissection or clearing; sides subparallel, straight to roundly truncate apex. Forceps 0.30 mm. long above ventral genital valve, 0.39 mm. long in entire length; maximum width 0.15 mm. in lateral view; outside lateral surface produced cephalad as a thin flange whose anterior margin forms a distinct convexity over region

from ventral genital valve to subapex; mesal face of flange distinctly ectad from that of thicker forcep proper; posterior margin practically straight from base to middle thence curved gently cephalad to base of apex; in dorsal view forceps curved gently mesad distally, terminating in a short, black, shallowly bifid tooth produced dorso-mesad from caudal two-thirds of mesal margin; in lateral view apices roundly truncate with apical tooth appearing as a black, blunt ridge. Outside face of forceps smooth except for a few small, scattered setae; inner face



Male forcep of *Euphalerus idahoensis* Jensen
Figure 1. Lateral view of inner face. Figure 1a. Dorsal view of apical tooth.
Figure 2. Lateral view of outer face.
(Drawings by Mrs. C. C. Low)

beset with large, acute setae arranged as follows: scattered or forming irregular rows over caudal half from apical tooth to ventral genital valve, a retrose group a little above base near anterior margin, another group on antero-mesal face of apex and a single row extending from antero-dorsal margin to ventral genital valve (thence curving cephalad) in a line closely paralleling posterior margin of forceps and forming a sharp line of demarcation between anterior flange and main body of forcep. In caudal view forceps strongly arched laterad in basal half with posterior margins convergent half way to apices. *Female:* Dorsal

genital valve 1.05 mm. long, over half as long as normally distended abdomen, tapering gradually to moderately acute apex; dorsal surface of apical half beset with many short, stout setae and a few long, slender hairs. Circum-anal ring elongate-ovate in outline, composed of a row of slit-like pores. Ventral valve shorter and more acute than dorsal; a group of slender hairs on ventral surface near base; elongate hairs and short setae sparse over distal half.

Holotype male, *Allotype* female and numerous *paratypes* collected at Pollock (Idaho County), Idaho (elevation 2300 ft.) July 19, 1943 on *Cercocarpus ledifolius* Nutt. (mountain mahogany) by D. D. Jensen. Six male and fifteen female paratypes collected on the same host at the same locality September 25, 1942 (Jensen). Holotype, allotype and paratypes will be deposited in the United States National Museum and paratypes in the collections of the California Academy of Sciences, J. S. Caldwell, L. D. Tuthill and the writer.

This species is closely related to *Euphalerus adustus* Tuthill but is readily distinguished by the difference in form of the male forceps. It is also somewhat larger and darker in color than *adustus*.

Adults only were taken. They were found on both the leaves and stems of mountain mahogany. The specimens collected September 25, 1942 were found in association with nymphs and adults of *Psylla difficilis* Tuthill.

MISCELLANEOUS PSYLLID RECORDS FROM IDAHO

Below are given some Idaho locality and host records for several species of Psyllidae with parasite records for hackberry psyllids. All collections were made by the writer except where otherwise indicated.

Psylla difficilis Tuthill: All collections were made from *Cercocarpus ledifolius* (mountain mahogany). Numerous adults and nymphs, Pollock (Idaho County), October 16, 1941, and September 25, 1942. (The specimens collected on the latter date were in association with *Euphalerus idahoensis* Jensen.) Adults only, Pollock and Whitewater (Idaho County), July 19, 1943. Adults and nymphs, Lucile (Idaho County), September 25, 1942. The nymphs of *difficilis* are naked and feed on the under surface of the leaves.

Psylla ribesiae (Crawford): Adults from wild currant (*Ribes* sp.), Arimo (Bannock County), May 29, 1937 (D. Farr and D. D. Jensen). Three adults and many nymphs collected on wild currant, Malta (Cassia County), July 10, 1943. Adults and nymphs of this species have been taken frequently by the writer in other western states. Although adults have been found on other plants, the nymphs have always been taken only on wild currant by the writer. They are naked and do not form waxy cells. Klyver (1932) reported having collected numerous nymphs and adults of this species from *Ceanothus thyrsiflorus*, at Stanford University, California. He stated that the nymphs produced waxy cells on the under side of the leaves. Two of Klyver's psyllid slides, labelled *ribesiae*, in the Stanford University collection were examined by the writer through the kindness of Professor G. F. Ferris. The slides carried a key number but not the host or locality data. Although labelled *ribesiae*, the adults on the slides are

unquestionably in the genus *Euphalerus*. One slide is of *E. vermiculosus* Crawford; the other is of *E. jugovenosus* Tut. *Ceanothus* is the true host for these species of *Euphalerus*, and the nymphs, at least of *jugovenosus*, form waxy cells on the under side of the leaves as described by Klyver (1932) for "*ribesiae*." In view of the above facts, it is the writer's opinion that the nymphs taken from *Ceanothus thyrsiflorus* by Klyver were not nymphs of *Psylla ribesiae*, but of a species of *Euphalerus*. Furthermore it is probable that *ribesiae* breeds only on *Ribes* species. This conclusion receives additional support from the fact that practically all published records for this species list *Ribes* as the host plant. Although these records refer almost exclusively to adults only, Tuthill (1943) reported examining several adults, accompanied by nymphs, which were collected on *Ribes* sp.

Psylla coryli Patch: Adults only collected from *Purshia tridentata* as follows: Bliss (Gooding County), October 5, 1941; Emmett (Gem County), October 8, 1941; Mann's Creek near Weiser (Adams County), October 12, 1941.

Psylla alba Crawford: One adult male from *Cercocarpus ledifolius*, Pollock (Idaho County), October 16, 1941. The presence of *alba* on this plant does not imply true host relationship as this species breeds on willow.

Arytaina pubescens Crawford: Adults only from *Purshia tridentata* as follows: Bliss (Gooding County), October 5, 1941; Mann's Creek near Weiser (Adams County), October 12, 1941; Midvale (Washington County), September 24, 1942.

Pachypsylla venusta (Osten Sacken): Numerous adults and nymphs of this well known species were collected from hackberry (*Celtis* sp.). Lucile (Idaho County), October 16, 1941. During February, 1942, four months after the leaf petiole galls had been collected, adults were still issuing from the galls held at room temperature.

Pachypsylla celtidis-mamma (Fletcher): Six adults collected on *Purshia tridentata*, Bliss (Gooding County), October 5, 1941. Adults and nymphs from hackberry (*Celtis* sp.), Lucile (Idaho County), October 16, 1941. The nymphs occurred in flattened leaf galls on the same trees which bore the galls of *Pachypsylla venusta* (O. S.).

Pachypsylla parasites: Hackberry foliage, carrying galls of *Pachypsylla venusta* and of *P. celtidis-mamma* was collected at Lucile, October 16, 1941, and left in a cage for several months. Between February and May, 1942, fourteen adult parasites emerged. These were identified by Mr. A. B. Gahan of the United States National Museum as *Eurytoma* sp., *Callimome* sp. and *Psyllaephagus* sp. near *pachypsyllae* (How.). Examination of the psyllid galls revealed that both species had been parasitized. However, it could not be determined definitely from which psyllid species the respective parasites had emerged.

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A NEW SPECIES OF DIRHAGUS WITH NOTES ON OTHER EUCNEMIDAE
(Coleoptera)

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Dirhagus wrighti n. sp.

Male.—Slender, elongate, subcylindrical; dark brown, clothed with short recumbent brown pubescence.

Head convex; clypeal margin sinuately rounded in front, margin greater than width between antennae; surface finely punctured; antennae when laid along side, extending to apical third of elytra, tapering in width toward outer joints, scape stout, second joint about as long as broad, third joint as long as scape, fourth to tenth joints inclusive of equal length, shorter than third, eleventh longer than third, third to tenth inclusive serrate.

Pronotum wider than long, wider than base of elytra; sides subparallel on basal half, broadly rounded anteriorly; anterior margin broadly rounded; posterior margin sinuate, hind angles prolonged; disk convex in front, depressed basally, small median depression and small round lateral depression each side at middle, sinuate lateral carina extending nearly to anterior margin, carina on hind angle extending to middle, anterior supplementary carina extending along front margin and down each side, then running diagonally, not reaching middle; surface finely, densely punctate. Scutellum elongate, truncate in front, rounded posteriorly.

Elytra elongate; sides subparallel, broadly rounded to suture at apices; disk convex; surface indistinctly striate, interspaces densely, minutely punctate.

Beneath, juxta-sutural sulcus deep, narrow, outer carina well marked. Metathoracic episterna broad, sides parallel. Posterior coxal plate dilated internally, sides parallel externally. Fourth tarsal segment lobed.

Length 6 mm.; width 2 mm.

Described from a specimen in author's collection, collected in light trap at New Smyrna, Fla., June 2, by Dr. Mike Wright and named for him.

This species runs to *D. impressicollis* (Bonv.) in Horn's key.[2] It can be separated, however, by the smaller median depression and the finer punctures on the pronotum.

I am indebted to Mr. W. S. Fisher, who kindly compared the specimen with West Indian species in the National Museum collection.

[1]Contribution from Department of Zoology and Entomology.

[2]G. H. Horn, 1886, Trans. Amer. Ent. Soc., 13 : 5–58.

Isorhipis obliqua (Say)

Eucnemis obliqua Say, 1839, Trans. Amer. Philos. Soc., 6 : 187.
Tharops obliquus LeConte, 1853, Trans. Amer. Philos. Soc., (2) 10: 412.
Tharops obliqua Bonvouloir, 1870, Ann. Soc. Ent. Fr., 105, pl. 5, fig. 1; Horn, 1886, Trans. Amer. Ent. Soc., 8 : 8; Van Horn, 1909, Proc. Wash. Ent. Soc., 11 : 54–61; Blatchley, 1910, Ind. Dept. Geol. & N. R., Bul. 1, 703.
Isorhipis ruficornis (Say) and *I. obliqua* (Say) of authors.

This species has been confused in the literature with *I. ruficornis* (Say). Both Bonvoulior and LeConte recognized the true *obliqua*. Van Horn figured *obliqua*. Blatchley figured *ruficornis*.

Large numbers of *I. obliqua* were reared from sugar maple, American beech and ironwood branches collected in Delaware Co., Ohio. Adults feign death and when disturbed are capable of springing at least an inch into the air. Numbers of the interesting parasite *Vanhornia eucnemidorum* Crawf. were reared from the infested sugar maple.

The beetles vary in length from 4.3 to 8.3 mm. Color varies from black with brown legs, antennae and an elongate area back of scutellum to black, with brown legs, antennae and elytra. Pygidium of both sexes has a strong median carina.

Isorhipis ruficornis (Say)

Melasis ruficornis Say, 1823, Jour. Acad. Nat. Sci. Phila., 3 : 166.
Eucnemis ruficornis (Say), 1836, Trans. Amer. Philos. Soc., 6 : 186.
Tharops ruficornis LeConte, 1853, Trans. Amer. Philos. Soc. (2) 10 : 411; Bonvouloir, 1870, Ann. Soc. Ent. Fr., 106, pl. 5, fig. 2.

Through the kindness of Dr. A. B. Champlain I have been able to examine specimens of *I. ruficornis* which I had reared years ago from infested black birch sticks collected at Mechanicsburg, Pa. They are black, with basal half of elytra, antennae and legs brown. The black apical area of elytra varies in size and LeConte records one with entire elytra brown. Pygidium of both sexes contains but a faint indication of carina and sculpture of elytral interspaces is much finer.

Dirhagus imperfectus (Lec.)

Specimens were reared from moist, decayed American beech log collected in Hocking Co., Ohio, by D. J. & J. N. Knull.

Hylochares nigricornis (Say)

Reared from decayed willow snag 8 inches in diameter collected in Hocking Co., Ohio, by D. J. & J. N. Knull. Most of the pupal cells were constructed in the sound wood near the base where moisture was more abundant. Adults vary in length from 3.3 to 9.5 mm.

Hylis terminalis (Lec.)

Reared from moist, decayed American beech log collected in Hocking Co., Ohio, by D. J. & J. N. Knull.

A REVIEW OF THE SPECIES OF BITING MIDGES OR CULICOIDES FROM THE CARIBBEAN REGION (Diptera: Ceratopogonidae)[1]

IRVING FOX

Formerly Captain, Sanitary Corps, Army of the United States

In the Caribbean region one soon becomes painfully familiar with the biting midges (or sand flies) that abound in the area. Although they are vicious bloodsucking pests and even transmitters of disease, little attention has been devoted to them by entomologists. But few species have been described and hardly anything has been done which would contribute to knowledge of their life history and control. This paper is an attempt to provide some of the fundamental taxonomic data which should precede any work on biology and control. In it new species are described, a key is given to the females of the known species, and their grographical distribution annotated. The paper is based upon the collections of the Department of Medical Zoology, School of Tropical Medicine at San Juan, Puerto Rico, which accumulated there largely through the efforts of the late Doctor William A. Hoffman.

Inadequate material has made it necessary to limit this consideration to the females. To be sure, in the final analysis, the taxonomy of the group cannot be complete until the terminalia of the males have been subjected to an exhaustive study. The males, however, infrequently come to hand; and a classification of the species based upon characters of the much more common females is a decided necessity. So far, the taxonomic characters of the female seem to be quite adequate to separate the species, and in some cases even better than the male terminalia. For example, Root and Hoffman (1937) in their consideration of the terminalia of *Culicoides furens* (Poey) state, "It should be noted, however, that it is only in greatly compressed mounts that the true form of the tip of the aedeagus, the apicolateral processes and especially of the harpes, can be seen. In mounts made without pressure the harpes may appear of an entirely different form."

In preparing specimens for study the writer attempts to secure both pinned and slide-mounted examples of each species, the former to be studied under a dissecting microscope, the latter under a compound microscope. From the pointed and pinned specimen the general size and coloration and the very important mesonotal pattern are ascertained; from the specimens mounted on slides the other details are worked out. In mounting specimens on slides the writer uses the beechwood creosote method reported by him in 1942—the specimens, if dried or previously preserved in alcohol, are simply allowed to remain in the crosote for 24 hours and thereafter mounted in balsam. It is

[1]Contribution from the School of Tropical Medicine, San Juan, Puerto Rico, and the 326th Station Hospital, APO 853, care of P.M., Miami, Fla. Thanks are due to Dr. Jose Oliver Gonzalez of the Department of Medical Zoology, School of Tropical Medicine and Major Joseph E. Rechany, M. C., AUS., for providing facilities to accomplish the work.

advisable to separate the head, thorax, abdomen and wings before applying the cover slip to the slide; this facilitates study of these structures. Where a species is represented by a single specimen, notes should be made upon the coloration and the specimen mounted on a slide.

The lack of material has necessitated the exclusion of Mexico from this treatment. The writer has seen examples of all the species treated except *debilipalpis* Lutz. From the area 18 species are now known. This number probably represents a small part of the total occurring in the region, and even casual collections made in the future may be expected to yield new species. Where a group bids fair to be abundant in species, as this one does, it is inadvisable to synonymize species whose type localities are widely separated, particularly if the evidence for the synonymy is to be found in only one sex. In his excellent paper of 1937, De Costa Lima synonymizes *diabolicus* Hoffman from Mexico with *guttatus* (Coquillet) from Brazil, and casts doubt on the validity of *trinidadensis* Hoffman from Trinidad, which he indicates may be a synonym of *insignis* Lutz from Brazil, all on the basis of examinations of the females of these species. The writer is inclined to reserve his opinion on these matters until more is known of the taxonomic characters and the distribution of the species. By the same token, hesitancy is desirable in reporting species from places very far removed from their type localities, as for instance, *baueri* Hoffman described from Maryland and reported from Mexico by Root and Hoffman (1937, p. 163)

The larvae and pupae of *furens* (Poey) and *phlebotomus* (Will.) have been described by Painter (1928) and the pupae of *borinqueni*, *arubae*, and *heliconae* Fox and Hoffman by the writer (1942). Otherwise little is known of the habitats of the immature stages, or their structure, for the remainder of the species. In the writer's paper of 1942 references are given to several important articles by European authors which treat of the immature stages of the group. Attention is invited to the outstanding papers of Dove, Hall, Hull, Platts, Prince, and Shields, published during the years 1932 to 1943, which deal with the economic importance and control of *Culicoides* in the United States (see Bibliography).

KEY TO THE FEMALES OF THE CARIBBEAN SPECIES OF CULICOIDES (EXCLUSIVE OF MEXICO)[2]

1. Second radial cell mainly included in a dark spot or stigma................2
   Second radial cell mainly included in a light spot.......................11
2. Stigma extending well beyond second radial cell so that more than half of first radial cell is in a dark spot.......................................3
   Stigma not extending well beyond second radial cell so that more than half of first radial cell is in a light spot.................................6
3. Anal cell with many macrotrichia; mesonotal pattern consisting of three longitudinal dark lines...**trilineatus**
   Anal cell with few or no macrotrichia; mesonotal pattern not as above........4

[2]Johannsen (1943, p. 779) indicates that *Ceratopogon decor* Williston (1896, p. 281) is of doubtful generic position and may be a *Culicoides*. The writer is not of the opinion that this is a *Culicoides*, hence it is excluded from the key. Another species not included in the key is *fluviatilis* Lutz reported from Panama by Dunn (1934, p. 178) and Fairchild (1943, p. 572) as a *Culicoides*; it is, however, a species of *Serromyia*, and not a *Culicoides*.

4. Vein M_2 obliterated, replaced by a series of horizontally direct macrotrichia; anal cell with one white spot distally..............................5
   Vein M_2 not obliterated, without macrotrichia; anal cell with two white spots distally one above the other..............................**castillae**
5. Mesonotal pattern distinct; legs conspicuously banded..............**hoffmani**
   Mesonotal pattern not distinct; bands of the legs inconspicuous....**borinqueni**
6. Vein M_2 bisecting a distinct white spot basally..............................7
   Vein M_2 passing below one to three spots, not bisecting a white spot basally..8
7. Legs uniform in color; mesonotum conspicuously bluish gray in appearance, **phlebotomus**
   Legs banded, femora with subapical and tibae with subbasal lighter annulations; mesonotum brown..............................**loughnani**
8. Distal portion of cell R_5 with three round white spots arranged in a triangle; mesonotal pattern not consisting of dark brown punctations.....**stubalensis**
   Distal portion of cell R_5 without three round white spots arranged in a triangle; mesonotal pattern consisting of dark brown punctations...........9
9. Middle third of cell R_5 with a prominent dark spot in the form of the numeral "2"..............................**arubae**
   Middle third of cell R_5 not as above, with a dark spot more or less in the form of an inverted letter "Y"..............................10
10. Cell M_1 with three light spots..............................**paraensis**
    Cell M_1 with two light spots..............................**furens**
11. Vein M_2 not bisecting a light spot basally..............................12
    Vein M_2 bisecting a light spot basally..............................13
12. Mesonotum with dark brown punctations..............................**oliveri**
    Mesonotum not as above..............................**debilipalpis**
13. Mesonotum with a distinct pattern..............................14
    Mesonotum without a distinct pattern..............................16
14. Size large, about 2.00 mm..............................**heliconiae**
    Size moderate, about 1.5 mm..............................15
15. Distal portion of vein R_{4+5} obliterated, second radial cell not completely outlined..............................**pseudodiabolicus**
    Distal portion of vein R_{4+5} not obliterated, second radial cell with outline complete and distinct..............................**diabolicus**
16. Distal portion of vein R_{4+5} obliterated; first radial cell parallel to the costa...17
    Distal portion of vein R_{4+5} not obliterated; radial cells diagonal to the costa, **trinidadensis**
17. Tibiae with subbasal lighter annulations; posterior portion of radius present in middle area..............................**inamollae**
    Tibiae uniform in color; posterior portion of radius obliterated in middle area..............................**painteri**

Culicoides trilineatus n. sp.

Diagnosis: A moderate sized species, the female of which is about 1.5 mm. long, dark brown in color with a distinctive mesonotal pattern, banded legs, and definite wing markings. It is distinguished from other species particularly by the mesonotal pattern which consists of three dark longitudinal lines and by having the wings densely provided with macrotrichia.

Description: Female. Head dark brown to black. Eyes narrowly separated. Antennae not suitable for study. Third palpal segment large, swollen beyond the middle with a large circular sensory pit. Second segment slightly shorter than the third; fourth and fifth segments subequal.

Mesonotum grayish brown, anteriorly with three dark brown longitudinal lines which converge in the middle area, the outside ones continuing posteriorly and outlining a grayish area which includes a pair of large dark spots in the prescutellar depression. Scutellum brown. For further details of the mesonotal pattern see fig. 5. Legs dark brown,

banded, but not conspicuously so; tibiae at least with subbasal lighter annulations and some of the femora with subapical ones. Abdomen dark brown; spermathecae not suitable for study.

Wing (fig. 11) about 1.00 mm. long and .40 mm. wide, abundantly provided with macrotrichia over most of the wing surface including the anal cell. Cell R_5 with two light spots. Cell M_1 with one or two light spots; vein M_2 indistinct, replaced by horizontally directed macrotrichia. Cell Cu_1 and anal cell with one light spot each. Second radial cell located in a dark spot (stigma) which extends posteriorly so as to include most of the first radial cell. Radio-median cross vein inconspicuous, located in a white spot. Subcosta and posterior portion of the radius obliterated.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Red Hook, St. Thomas, September 11, 1937, biting in the afternoon.

Culicoides castillae n. sp.

Diagnosis: A small species, the female of which is about 1.00 mm. long, dark brown in color with a distinctive mesonotal pattern, banded legs, and definite wing markings. It superficially resembles ***hoffmani*** new species from which it differs among other ways in having two white spots in the distal portion of the anal cell and in the character of the mesonotal pattern.

Description: Female. Head dark brown. Eyes very narrowly separated. Antennae not suitable for study. Third palpal segment enlarged but not markedly swollen beyond the middle with a large circular sensory pit. Second palpal segment about as long as the third; fourth segment longer than the fifth.

Mesonotum with two broad longitudinal dark bands enclosing a grayish area which posteriorly includes two large dark brown to black spots. Anteriorly the broad bands converge forming a dark area which extends laterally on each side in the form of transverse bands. Scutellum dark brown medially, grayish at the sides. For further details of the mesonotal pattern see fig. 3. Legs dark brown, banded, tibiae with subbasal lighter annulations and femora with subapical ones. Abdomen brown; spermathecae apparently single, but the specimen is not suitable for accurate study of this structure.

Wing (fig. 2) about .94 mm. long and .40 mm. wide with few macrotrichia which are limited to cells R_5 and M_1. Cell R_5 with four light spots. Cell M_1 with two light spots. Cell M_2 and Cell Cu_1 with one light spot each. Anal cell with three white spots. Second radial cell included in a dark spot which extends posteriorly to include most of the first radial cell. Radio-median cross vein inconspicuous, located in a light spot. Subcosta obliterated.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Puerta Castilla, Honduras, May, 1926, collected by R. H. Painter.

Culicoides hoffmani n. sp.

Diagnosis: A small species, the female of which is about 1.00 mm. long, brown in color with a distinctive mesonotal pattern, conspic-

uously banded legs, and definite wing markings. The mesonotal pattern is similar to *castillae* new species, but the markings and structure of the wing are very different.

Description: Female. Head dark brown. Eyes narrowly separated. Antennae not suitable for study. Third palpal segment markedly swollen at the middle bearing a large circular sensory pit. Third segment longer than the second.

Mesonotum with two triangular brown markings between which is a grayish area, which broadens posteriorly and includes two prominent dark spots in the prescutellar depression. Scutellum dark in the medial area, light at the sides. For further details of the mesonotal pattern see fig. 6. Legs dark brown, conspicuously banded; femora I and II with subapical lighter annulations, femora III uniform dark brown; all the tibiae with subbasal annulations and tibiae III with subapical ones as well. Abdomen dark brown; spermathecae double, subpsherical, one slightly larger than the other.

Wing (fig. 9) about .80 mm. long and .34 mm. wide, provided with macrotrichia in the apical region. Cell R_5 with three light spots. Cell M_1 with two light spots. Vein M_2 obliterated, replaced by horizontally directed macrotrichia. Cells M_2 and Cu_1 with one light spot each. Second radial cell included in a dark spot which extends posteriorly to include most of the first radial cell. Radio-median cross vein indistinct, located in a light spot. Subcosta and posterior portion of the radius obliterated.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Camuto Village, Trinidad, April 11, 1941, biting, the types selected from a small series.

Culicoides borinqueni Fox & Hoffman

Culicoides borinqueni Fox & Hoffmah, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 110, 1944.

Distribution: Known only from Puerto Rico. A further record from Puerto Rico is Luquillo, May 12, 1932, female from a tree hole.

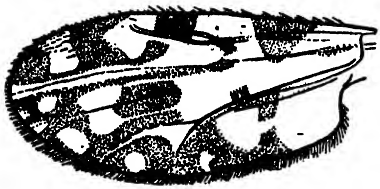
Culicoides phlebotomus (Williston)

Ceratopogon phlebotomus Williston, Ent. Soc. London, Trans., p. 281, 1896.
Culicoides phlebotomus Hoffman, Amer. Jour. Hyg., Vol. V, p. 285, 1925.
Culicoides phlebotomus Painter, Ann. Rpts. United Fruit Co. Med. Dept., p. 258, 1926.
Culicoides phlebotomus Root & Hoffman, Amer. Jour. Hyg., Vol. XXV, p. 151, 1937.
Culicoides phlebotomus Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. II, p. 414, 1937.

EXPLANATION OF PLATE I

(All drawings pertain to the female sex)

Fig. 1. *C. pseudodiabolicus* n. sp., wing. Fig. 2. *C. castillae* n. sp., wing. Fig. 3. *C. castillae* n. sp., mesonotal pattern. Fig. 4. *C. oliveri* Fox & Hoffm., wing. Fig. 5. *C. trilineatus* n. sp., mesonotal pattern. Fig. 6. *C. hoffmani* n. sp., mesonotal pattern. Fig. 7. *C. stubalensis* n. sp., mesonotal pattern. Fig. 8. *C. stubalensis* n. sp., wing. Fig. 9. *C. hoffmani* n. sp., wing. Fig. 10. *C. painteri* n. sp., wing. Fig. 11. *C. trilineatus* n. sp., wing.



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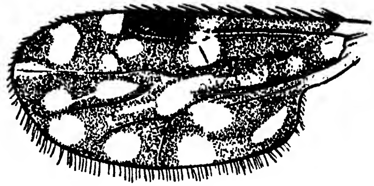

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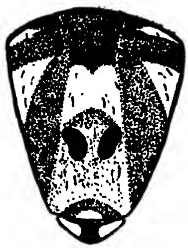

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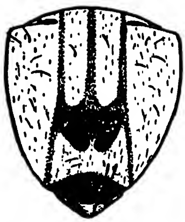

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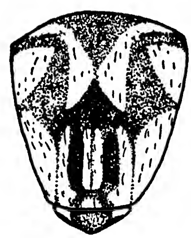

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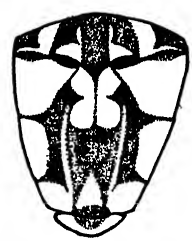

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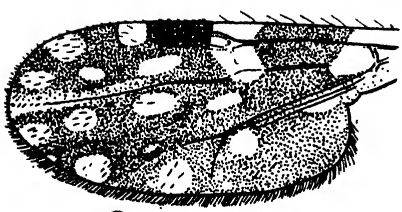

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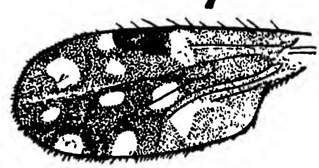

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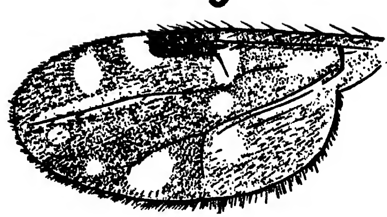

11

Distribution: Known from the West Indies and Honduras. A further record is St. Croix, Cotton Valley, Sept. 8, 1937, a small series of females collected by Hoffman and Beatty.

Culicoides loughnani Edwards

Culicoides loughnani Edwards, Bul. Ent. Res., Vol. XIII, p. 165, 1922.
Culicoides loughnani Hoffman, Amer. Jour. Hyg., Vol. V, p. 282, 1925.
Culicoides loughnani Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 413, 1937.

Distribution: Known only from Jamaica. A further record from Jamaica is, female, Dec., 1933, collected by Dr. Kumm (no further data).

Remarks: Along with the original description of this species Edwards described a variety—*Culicoides loughnani var. jamaicensis*—from the same locality, Kingston, Jamaica. In the absence of adequate material from Jamaica, the writer is not able to determine the status of this name. It may represent a true variety, which is doubtful since it occurs in the same type locality, or it may be a distinct species. The possibility that it is a synonym of *C. l. loughnani* should not be dismissed.

Culicoides stubalensis n. sp.

Diagnosis: A moderate sized species, about 1.5 mm. long, brown in color with a distinctive mesonotal pattern, banded legs, and definite wing markings. It differs from other species in having three round light spots arranged in a triangle in the distal portion of cell R_5 of the wing.

Description: Female. Head brown. Eyes narrowly separated. Antennae with the last five segments longer than the first eight. Third palpal segment large, swollen beyond the middle with a large circular sensory pit. Second palpal segment shorter than the third, fourth and fifth segments subequal.

Mesonotum with two broad longitudinal brown bands enclosing a gray area anteriorly and a brown area posteriorly. Laterally there are gray bands interrupted by strands from the brown ones. Scutellum brown medially, gray at the sides. For further details of the mesonotal pattern see fig. 7. Legs brown, banded, femora with subbasal and subapical light annulations, tibiae at least with subbasal annulations, some of them with subapical ones as well. Abdomen dark brown; spermathecae double, subspherical, one much larger than the other.

Wing (fig. 8) about 1.10 mm. long and .44 mm. wide, abundantly provided with macrotrichia in the distal half. Cell R_5 with five light spots, the three distal ones arranged in a triangle. Cell M_1 with three light spots, vein M_2 passing below them. Cell M_2 with one or two light spots. Cell Cu_1 with one light spot. Anal cell with two light spots. Radio-median cross vein and most of the first radial cell indistinct, located in a light spot. Second radial cell located in a dark spot (stigma). Subcosta and posterior portion of the radius obliterated.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Stubal's Bay, Trinidad, July 4, 1941, collected from a light trap. The types were selected from a series of specimens.

Culicoides arubae Fox & Hoffman

Culicoides arubae Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 109, 1944.

Distribution: Known only from Aruba, Dutch West Indies.

Culicoides paraensis (Goeldi)

Haematomyidium paraense Goeldi, Mus. Goeldi Mem. Vol. IV, p. 137, 1905.
Culicoides paraensis Lutz, Inst. Oswaldo Cruz Mem., Vol. V, p. 55, 1913.
Culicoides paraensis Dunn, Psyche, Vol. XLI, p. 178, 1934.
Culicoides paraensis Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 414, 1937.
Culicoides paraensis Lutz and Nunez Tovar, in Carbonell's, La Parasitologia en Venezuela, Caracas, p. 258, 1938.
Culicoides paraensis Martorell, Puerto Rico Univ. Jour. Agr., Vol. XXIII, p. 210, 1939.
Culicoides paraensis Fairchild, Amer. Jour. Trop. Med., Vol. XXIII, p. 572, 1943.

Distribution: Described from Brazil and reported from Panama by Dunn and Fairchild, and from Venezuela by Lutz and Nunez Tovar and Martorell. Martorell states, "Of great economic importance, the only representative of this family in the region. This troublesome fly becomes a nuisance during the rainy season, attacking people with great aggressiveness and voracity. It is very abundant and initiates its attacks during the first hours of the morning as well as at dusk. Its common name among the people of the Valley is 'jejen'."

Culicoides furens (Poey)

Oecacta furens Poey, Mem. sobre la Hist. de la Isla Cuba, Vol. I, p. 237, 1853.
Ceratopogon maculithorax Williston, Ent. Soc. London, Trans., p. 277, 1896.
Culicoides maculithorax Lutz, Inst. Oswaldo Cruz Mem., Vol. V, p. 53, 1913.
Culicoides furens Hoffman, Amer. Jour. Hyg., Vol. V, p. 287, 1925.
Culicoides furens Painter, Ann. Rpts. United Fruit Co. Med. Dept., p. 255, 1926.
Culicoides furens Root & Hoffman, Amer. Jour. Hyg., Vol. XXV, p. 162, 1937.
Culicoides furens Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 414, 1937.
Culicoides furens Macfie, Ann. and Mag. Nat. Hist., Vol. XX, p. 10, 1937.

Distribution: "This species is very widely distributed in tropical America, from the West Indies and Mexican coast to Brazil" (Root & Hoffman). It has been reported from Cuba, Puerto Rico, Jamaica, St. Vincent, Bahamas, Trinidad, Brazil, Mexico, Panama, Honduras, and Florida, Louisiana and Texas. Further records are: St. John, Cruz Bay, Sept. 9, 1937, three females; Santo Domingo, San Lorenzo, May 14, 1941, female, biting, collected by Dr. Mazzotti; Trinidad, Stubal's Bay, July 4, 1941, a series of females from a light trap.

Culicoides oliveri Fox & Hoffman

Culicoides oliveri Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 108, 1944.

Distribution: Known only from Haiti.

Remarks: The female wing of this species is illustrated in fig. 4.

Culicoides debilipalpis Lutz

Culicoides debilipalpis Lutz. Inst. Oswaldo Cruz Mem., Vol. V, p. 60, 1913.
Culicoides debilipalpis Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 415, 1937.
Culicoides debilipalpis Macfie, Ann. and Mag. Nat. Hist., Vol. XX, p. 7, 1937.

Distribution: Described from Brazil and reported from Trinidad by Macfie.

Culicoides heliconiae Fox & Hoffman

Culicoides heliconiae Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 108, 1944.

Distribution: Known only from Venezuela.

Culicoides pseduodiabolicus n. sp.

Diagnosis: A moderate sized species, the female of which is about 1.5 mm. long, brown in color, with a distinctive mesonotal pattern, banded legs, and definite wing markings. It resembles *diabolicus* Hoffman from which it differs in having a mesonotum with a pair of large prominent dark spots in the prescutellar depression rather than small ones and in having the distal portion of vein R_{4+5} obliterated rather than as in that species.

Description: Female. Head dark brown to black. Eyes contiguous. Antennae with the last five segments much longer than the first eight. Third palpal segment swollen at the middle, bearing a sensory pit, thereafter tapering distally. Second segment slightly shorter than the third; fifth segment shorter than the fourth.

Mesonotum with two longitudinal brown bands which anteriorly expand laterally forming transverse extensions. The bands outline a gray area which includes two prominent dark brown kidney shaped spots in the anterior portion of the prescutellar depression. Scutellum gray, somewhat darker medially. Legs brown, banded; femora I and II with subapical lighter annulations, femora III uniform brown, tibiae I and II with subbasal annulations, tibiae III with both subbasal and subapical ones. Abdomen brown; spermathecae not suitable for study.

Wing (fig. 1) about 1.00 mm. long and .42 mm. wide, sparsely provided with macrotrichia in the distal portion particularly in cells R_5, M_1 and M_2. These three cells with two light spots each. Distal portions of veins M_1 and M_2 with horizontally directed macrotrichia; the latter vein separates the posterior light spots in cells M_1 and M_2. Cell Cu_1 with one light spot. Inner borders of veins Cu_1 and Cu_2 light. Anal cell with two or three light spots. Distal portion of vein R_{4+5} obliterated. Radio-median cross vein in a dark spot basally.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Camuto Village, Trinidad, July 7 and 9, 1941, resting on walls of a stable. The types were selected from a series of specimens.

Culicoides trinidadensis Hoffman

Culicoides trinidadensis Hoffman, Amer. Jour. Hyg., Vol. V, p. 286, 1925.
Culicoides trinidadensis Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 415, 1937.

Distribution: Known only from Trinidad. A further record of this species in Trinidad is Stubal's Bay, July 4, 1941, a series of females taken from a light trap.

Culicoides inamollae Fox & Hoffman

Culicoides inamollae Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 110, 1944.

Distribution: Known only from Puerto Rico.

Remarks: In the original description it was stated that the legs of this species are without lighter annulations. A re-examination revealed the presence of subbasal and subapical annulations on the hind tibiae, at least.

Culicoides diabolicus Hoffman

Culicoides diabolicus Hoffman, Amer. Jour. Hyg., Vol. V, p. 294, 1925.
Culicoides diabolicus Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 415, 1937.
Culicoides diabolicus Macfie, Ann. and Mag. Nat. Hist., Vol. XX, p. 9, 1937.

Distribution: Described from Panama and reported from Trinidad by Macfie. In the collection there is a specimen mounted on two slides bearing the following data: "Cabima, Panama, May 25, 1911, A. Busck Coll."

Culicoides painteri n. sp.

Diagnosis: A moderate sized species the female of which is about 1.3 mm. long, yellowish brown in color, without a distinctive mesonotal pattern, with legs uniform in color, and definite wing markings. The distal portion of vein R_{4+5} is obliterated and the first radial cell is parallel to the costa.

Description: Female. Head dark brown. Eyes and antennae not suitable for study. Third palpal segment large and swollen at the middle. Second palpal segment shorter than the third; fourth and fifth segments subequal.

Mesonotum yellowish brown without a distinctive design in the pinned specimen available which apparently has been on a pin for almost twenty years and is in poor condition. Scutellum concolorous with the mesonotum. Legs unbanded, yellowish brown in color. Abdomen brown; spermatheca not suitable for study.

Wing (fig. 10) about 1.00 mm. long and .40 mm. wide, with very few macrotrichia. Cell R_5 with two light spots. Cell M_1 and cell M_2 with two light spots. Vein M_2 distally obliterated and replaced by horizontally directed macrotrichia, basally it separates the posterior light spots in cells M_1 and M_2. Cell Cu_1 with one light spot, the inner borders of veins Cu_1 and Cu_2 light. Anal cell with three light spots. Subcosta and posterior portion of the radius obliterated. Distal portion of veins R_{4+5} obliterated, located in a light spot. Radio-median cross vein in a small dark spot basally.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Puerta Castilla, Honduras, April 20 and 29, 1926, collected by R. H. Painter.

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Hull, J. B., Dove W. E., and **Prince F. M.** 1934. Seasonal incidence and concentrations of sand fly larvae, *Culicoides dovei* Hall, in salt marshes (Ceratopogonidae: Diptera). Jour. Parasitol. XX, pp. 162–172.

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Platts, N. G., Shields, S. E., and **Hull, J. B.** 1943. Diking and pumping for control of sand flies and mosquitoes in Florida salt marshes. Jour. Econ. Ent., XXXVI, 409–412.

Shields, S. E., and **Hull, J. B.** 1943. The seasonal incidence of sand flies in Florida. Jour. Econ. Ent., XXXVI, p. 625.

U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine. 1938. "Sand flies" and "Punkies." Mimeograph circular E-441.

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[3]Other references may be found in the systematic discussion.

SIMULIDOS DEL NUEVO MUNDO, by LUIS VARGAS. Monografia 1 del Instituto de Salubridad y Enfermedades Tropicales. 241 pages, 10 plates. Mexico, D. F., 1945.

The first sixty-eight pages of this publication are devoted to the bionomics of the insects, including a discussion of economic importance, morphology, life cycle, methods of rearing and predators and parasites. This part contains all of the ten plates. The remainder is a systematic survey of unusual organization. It includes a few pages of general discussion followed by a brief historical section summarizing the classifications proposed by Enderlein, Twinn and Rubzov. The second division lists the genera alphabetically, with reference to subfamilies and tribes, brief bibliographies, and a statement of the genotypes. The last are indicated simply as type, without comment on the method of fixation. The third section lists the species alphabetically with synonymy, brief bibliographies, location of types and distribution. All species are assigned to the genus *Simulium*. Part IV lists the species by countries, Part V is an index to generic and specific names, and Part VI is a bibliography of seventeen pages.—A. W. L.

THE GENUS BANDARA BALL
(Homoptera: Cicadellidae)

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Genus **Bandara** Ball

1931. Bull. Brooklyn Ent. Soc. 26: 93.

This is a small group of golden yellow leafhoppers, closely related, and intermediate between *Eutettix* and *Mesamia*. Three species, *B. johnsoni* (V. D.), the genotype; *animana* (Ball) and *aurata* (Ball) have been described and three additional species are described here.

B. animana (Ball) is represented by the single male holotype in the U. S. N. M. Collection and has not been examined. The description indicates that it is quite distinct from the species treated here.

An interesting additional character is the secondary seta, occasionally more than one, on the antenna, which emerges at the base of the third segment.

Through the kindness of Dr. C. F. W. Muesebeck and Dr. R. H. Beamer material from the National Museum and from the University of Kansas collections was included in this study.

KEY TO BANDARA

1. Elytra with pale rounded spots....................2
   Elytra unicolorous....................**aurata**
2. Aedeagus in male narrow, split at apex; last ventral segment in female with prong either side of a median notch....................3
   Aedeagus broad; female segment with median portion produced....................4
3. Aedeagus in lateral view short, straight, distinctly bifid apically; in female segment deeply incised at middle....................**johnsoni**
   Aedeagus in lateral view bent dorsad near apex; apical prongs appressed; median incision in female segment shallow....................**curvata**
4. Pygofer process in male long, heavy, straight; female segment with median portion broadly produced....................**inflata**
   Pygofer process short, stout and spiny; female segment with narrow notched median projection....................**parallela**

Bandara johnsoni (V. D.)

Eutettix johnsoni Van Duzee, Can. Ent. 26: 136–7, 1894.

Described originally from specimens collected in Philadelphia, Pa. Specimens have been examined from Conn., Maine, Md., Mass., Miss., N. J., N. Y., Ohio, Tenn. and Virginia.

The more complete description of the genitalia will supplement Van Duzee's excellent description.

Female.—Last ventral segment one-fourth longer than broad, with median longitudinal carina; posterior margin with sides cut out, straight, incised at middle one-fourth or more length of segment, a small prong either side of incision not extending far beyond segment.

Male.—Valve broad, triangular, apex truncate; plates broad and short, narrowed on apical third to blunt apices; pygofers short and stout, a short narrow spike on ventral edge; styles narrowed to long, blunt chitinized finger apically; aedeagus with almost semi-circular base, lower edges narrowed to sharp lateral spines; shaft slender, in ventral view straight, parallel-sided to apical third where it is distinctly bifid, prongs well separated; in lateral view straight, a rather broad dorsal projection near middle extends back even with base, this projection is a third longer than broad and more heavily chitinized on ventral surface. The narrower base and curved, distinctly bifid aedeagus distinguish this from *B. curvata* n. sp.

Length: male 4.5–4.75 mm.; female 5–5.5 mm.

Bandara curvata n. sp.

Resembling *B. johnsoni* (V. D.) very closely in color pattern, usually a little smaller, but with distinct genitalia in both sexes. The distribution is more generally southern and western than in *johnsoni.*

Vertex sloping, slightly longer at middle than next to eye, anterior margin forming a distinct ridge in lateral view. Pronotum slightly broader than head; more than twice as broad as long. Anterior margin evenly rounded, posterior margin almost transverse. Elytra long, broad, apices rounded, venation distinct.

Color: Vertex creamy yellow, six black dots in pairs on anterior margin, median pair close together, outer pairs either side of ocelli, outermost dots next to black eyes; disc golden; posterior margin with four creamy transverse yellow spots, median larger, lateral triangular next to eyes. Pronotum golden with median narrow yellow stripe from base almost reaching anterior margin, a pair of lateral broader stripes extending beyond middle and several pale spots below eye. Scutellum golden with pale triangular areas either side of dark impressed median line, and apex pale. Elytra golden, darker in male, subhyaline, with distinct pale spots as follows on each: three small round spots evenly spaced along suture, one at middle, others half way between it and humeral angle; humerus along claval vein; and two small spots on anterior disc. Corial and apical pale spots are larger and more diffuse toward the hyaline costa and form three irregular transverse bands; anterior starting opposite apex of clavus, median just anterior to crossveins and posterior across anterior discs of apical cells. In the male, dark brown points appear at apex of clavus, inner apical crossveins and outer veins in costal margin. Below pale yellow, spines on hind legs darkened at base; wavy black line below apex of head broken at middle and narrowed below ocelli.

Female[1]: Last ventral segment short, with a median longitudinal carina, lateral angles incised, median posterior margin with pair of long projecting teeth, incision dividing them scarcely deeper than margin. Pygofer and ovipositor stout, short, stout bristles either side of ovipositor.

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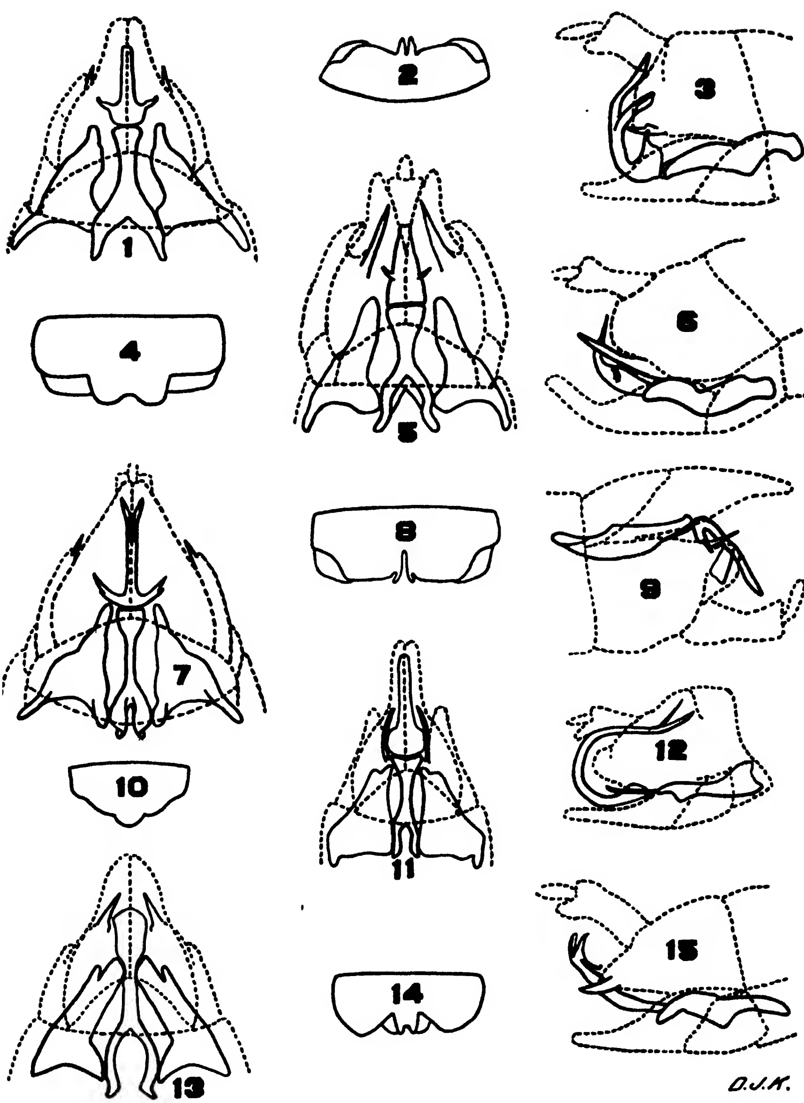
[1]Drawings for ***Eutettix (Mesamia) johnsoni*** Ball, Proc. Dav. Acad. Sciences 12: 66, pl. 3, figs. 8b, 8c, probably refer to this species.



Figs. 1–15. *Bandara curvata* n. sp. 1–3; *inflata* n. sp. 4–6; *johnsoni* (V. D.) 7–9; *aurata* (Ball) 10–12; *parallela* n. sp. 13–15.

Male.—Valve bluntly triangular; plates broad at base, narrowed to rounded apices on apical third; styles blunt, heavily chitinized; pygofer with short stubby process on inner margin, sometimes bluntly toothed; aedeagus in ventral view with broad rectangular base, a dorsally curved prong from each lower outer angle; shaft long and narrow, parallel-sided to apical third where it is split, but the parts usually remain appressed, seldom as widely separated as in *B. johnsoni.* In lateral view the apical third is curved dorsad at somewhat less than a right angle, the apex bent slightly down, a thin dorsal process, chitinized more heavily on its ventral margin, arises at about half length of shaft and extends back parallel with and as far as the apex.

Length: male, 4.5 mm.; female, 5 mm.

In the collection of The Ohio State University: Male *holotype*, Delaware Co., Ohio, Sept. 9, 1945, D. J. & J. N. Knull; *allotype*, Delaware Co., Ohio, Sept. 9, 1943, D. J. & J. N. Knull; paratypes from Ohio: Clyde, Aug. 26, 1934, Whittington, A. C. Miller Collection; Champaign Co., Aug. 31, 1931, E. P. Breakey; Fairfield Co., June 16, 1945; and Hocking Co., Sept. 3, 1939 and Sept. 14, 1944, D. J. & J. N. Knull. From Iowa: Ames, Aug. 13, 1896, Experiment Station, Aug. 25, 1897 and Sept. 10, 1895, H. Osborn. From Mississippi: Agr. College, July 20, 1920, A. McIntosh; Durant, June 10, 1933; Heidelberg, June 6, 1934, *Fraxinus:* Leland, May 30, 1933; and Okoloma, June 14, 1934, all D. W. Grimes. From Tennessee, Great Smoky Mt. Nat. Park, June 7 and 21, 1942, D. J. and J. N. Knull, on persimmon.

Paratypes in Collection of the University of Kansas: Prattsburg, Ga., July 25, 1930, R. H. Beamer; Magnolia, Tenn., Feb. 4, 1915; Clarkesville, Tenn., Aug. 13, 1914; Arlington, Va., Sept. 19, 1943, R. H. Beamer.

Paratypes in U. S. N. M. Collection: Cuthbert, Ga., May 16, 1916, W. D. Pierce; Hardison Co., Ga., June 26, 1940, *Prunus angustifolia*, Turner; D. C., July 9, 1886, T. Pergande; Glenn Echo, Md., Summer 1922, J. C. Bridwell; Plummers Id., Md., July, 1907, Wm. Palmer; Md.; Hamilton Co., Tenn., May 28, 1939, Turner; Nelson Co., Va., July 19, 1924, W. Robinson; Vienna, Va., Sept. 20, 1932, J. C. Bridwell.

Bandara inflata n. sp.

Large, in general form and color pattern very similar to *johnsoni* and *curvata*, the color is generally more orange gold, white spots small and distinct on clavus; outer edges of elytra becoming almost entirely hyaline, pale bands broader; and in most specimens the scutellum is bright yellow except for golden basal angles.

Female.—Last ventral segment truncate and produced on median third in rather angulate lobe, indented at middle.

Male.—In ventral view valve short, obtusely triangular; plates broad on basal two-thirds, narrowed and slightly divergent apically, exceeding pygofer; aedeagus broad on basal half, with a pair of short spines curved down near base, and apex which is curved dorsad is divided forming two attenuate divergent spines; pygofer rounded, a long heavy spine on ventral edge reaching almost to apex of plate; styles broad, blunt and heavily chitinized.

Length: Male, 5 mm.; female, 5.5 mm.

Male *holotype*, Franklin Co., O., Aug. 10, 1931, E. P. Breakey; *allotype*, Fairfield Co., O., July 10, 1945, D. J. & J. N. Knull; *paratypes*, Worthington, Brown Fruit Farm, O., Aug. 21, 1928; and Tryon, N. C., light, July 20, W. F. Fiske. These are in the Collection of the Ohio State University. One male *paratype* in U. S. N. M., Raleigh, N. C., mid-July, 1909.

Bandara parallela n. sp.

A small, dark form with parallel-margined vertex. Some males are brown with a dark dorsum which shows through the elytra. Some specimens have an indication of dark arcs on face. In respect to general structure and color pattern it closely resembles *B. curvata*.

Female.—Segment short with three lobes of equal length, lateral broad, median narrow and incised about one-third its length.

Male.—Plates broad, gradually tapered to blunt apices, valve obtusely triangular, a little more than one-third length of plates, pygofer short, not much exposed in ventral view, exceeded by plates, a unique heavy, sharp-pointed process on posterior ventral margin projecting and covered except for apex by a thick hairy coat. Aedeagus broad in ventral view, curved dorsad toward apex, two pairs of delicate processes project from lateral edges near apex, anterior turns sharply up close to shaft, then latero-dorsad apically; posterior is broader at base, bent almost at right angle to shaft, and turned up at apex. Styles blunt tipped and heavily chitinized.

Length: Male, 4.25 mm.; female, 4.5–5 mm.

Male *holotype*, Hocking Co., O., Sept. 5, 1945; *allotype*, Fairfield Co., O., July 10, 1945; *paratypes*: Delaware Co., O., Sept. 1, 1944, all D. J. & J. N. Knull; Orono, Me., Aug. 6, 1913, H. Osborn; Ames, Ia., Sept. 3, 1892, H. Osborn; A. & M. College, Miss., May 29, 1930, R. I. Horst. These are in the Collection of The Ohio State University. *Paratypes* in the U. S. N. M. Collection: Catons Bush, Sept. 25, Baker Coll.; Forest Glen, Md., Sept. 15, 1915, O. Heidemann; Glen Echo, Md., summer, 1922, J. C. Bridwell; and Washington, D. C., No. 2059. Collection of the University of Kansas: Clarkesville, Tenn., Aug. 8, 1915; Douglas Co., Kans., June 21, 1928, P. B. Lawson; Fulton, Miss., July 14, 1930, R. H. Beamer; Prattsburg, Ga., July 25, 1930, L. D. Tuthill.

Bandara aurata (Ball)

Eutettix (*Mesamia*) *aurata* Ball, Can. Ent. 41: 81–2, 1909.

This small golden species was described from a single female from Washington, D. C. It differs from other *Bandara* species in that the elytra are unicolorous. In some specimens examined, particularly in males, the dark coloring of the head is very pronounced.

Female.—Last ventral segment long, triangular, longitudinal carina at middle, gradually produced from lateral margins to small rounded lobe at middle.

Male.—Valve short, blunt, triangular; plates long, slender, narrow on outer half; pygofers short, stout, with a weak spine on ventral margin extending well beyond pygofer and curved in slightly. Styles with apices notched, inner lobe produced finger-like; aedeagus with base almost square, shaft very long, narrow, curved evenly forming a large, more than complete semi-circle, apex divided into two long divergent spines, apices extending beyond base in lateral view.

Length: Male, 4–4.25 mm.; female, 4.5 mm.

In The Ohio State University Collection: Licking Co., O., Aug. 5, H. Osborn; Franklin Co., O., Aug. 10, 1931, E. P. Breakey, *Acer*; Carolinas, June 19, 1928, D. M. DeLong; Durant, Miss., June 10, 1934, D. W. Grimes, *Crataegus.*

INSECT DIETARY, by Charles T. Brues. pp. xxvi+466, 22 plates, 68 text figures. The Harvard University Press, 1945. Price $5.00.

The name of the author is advance notice of the comprehensiveness of his work. Although it is not a large volume in actual bulk, it covers an incredible amount of factual material in extremely readable form—readable, that is, to a biologist. The reviewer, at least, suspects that the layman might bog down in its uninhibited scientific vocabulary, although he should appreciate from one point of view or another such items as the comparison of a rigidly monophagous insect to a "teetotaler who would die of thirst in the midst of aqueous liquids defiled by the taint of one-half percent alcohol."

It would be futile to attempt a summary of the contents of such a book. Its chapters cover a survey of the abundance and diversity of insects, types of food habits and their relation to structure and environment, herbivorous insects, gall insects, fungi and microbes as food and symbiosis with microorganisms, predatory insects, parasitism, external parasites, internal parasites and insects as food. Each chapter has an ample bibliography and the book concludes with separate indices to authors and subjects.

The writer shows in his foreword a nice appreciation of trends in biological science, expressed with such facility that it lightens the end of a busy day. A small example says that "Entomologists can speak with fervor of the intricacies of taxonomic investigation. Among all biologists, they seem to have made the worst mess of it, characterizing so many families, genera and species that they have far outstripped the whole field of their taxonomist brethren. This is not really their fault; it is merely a feeble attempt to sort out the avalanche of insects that Nature has lavished on the Earth." But read it yourself. However much you may know about insects you are sure to learn a lot more and learn it with enjoyment if terms like monophagous and oligophagous and hypogaeic do not disturb the serenity of your reading.—A. W. L.

A REVIEW OF THE NEARCTIC LEPIDOSTOMATIDAE (TRICHOPTERA)

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The males of this caddis fly family are unusual in the number of very odd structural developments of many appendages. Noteworthy of these secondary sexual characters are enlargement or folding of the wings, plate-like expansion of some of the leg segments, oddly shaped branches, grooves or twisted regions of the basal antennal segment, and many diverse shapes assumed by the maxillary palpi. None of these characters has any similar counterpart in the female. Until recent years, these unusual male structures were used as a basis for generic definition. So abundant are these characters that in 1936 about 15 genera had been erected for the reception of the less than 25 Nearctic species recognized in the family at that time. Few of these genera or species were recognizable in the female sex.

Since that time the association of larvae and adults of several of these forms has shown that the immature stages offer no characters which corroborate the generic divisions used for the males. Further study of the North American species showed that the male genitalia provided a number of characters for grouping the species into a few fairly well marked groups. In many cases each of these groups contained forms with quite different modifications of wings, antennae, or palpi, and it appeared fairly clear that these latter characters had little relation to the phylogenetic grouping of the species within the family. In an effort to substantiate these findings, a detailed study of the female genitalia was undertaken. It was found that the spermatheca presented a series of characters which grouped the females in exactly the same way that the male genital characters grouped the males.

It seems evident from this that a large number of the genera in this family based on the strange modification of the males do not represent basic groupings of the species and that many of them should be synonymized. The result of these remarks was indicated previously by Ross (1938 and 1944); in the latter report only two genera, *Lepidostoma* and *Theliopsyche*, have been recognized for reception of the Nearctic species. In this paper, I have made a preliminary segregation of the species of *Lepidostoma* into what appear to be fairly well defined groups based primarily on the genitalia of the two sexes.

At the present time a large number of generic names are employed for members of this family for other regions of the world. Many of these genera are based on the same type of secondary sexual characters as have been used for the North American species. It is probably that, at least to some extent, the same situation exists among these as has been found in the North American species, and that some modification of the generic concept of these forms will ultimately be necessary. Such a study, however, will have to be based on a correlation of the

male and female genitalia and preferably the larvae also. Since this material is not available to me for study, I have not attempted in this paper to treat names other than those concerning North American species.

To date larvae of only *Lepidostoma* are known, *Theliopsyche* larvae never having been associated with the adults. An examination of several reared species of *Lepidostoma* and many unassociated collections of larvae of the genus has failed to show more than a few slight color differences between species. This paper, therefore, deals only with the adult form.

The purpose of the present paper is (1) to offer a key to the males and identified females in the family, (2) to summarize references to the original descriptions and to additional published illustrations of diagnostic characters, (3) to present drawings of the male genitalia for certain species which have not previously been illustrated, and (4) to describe the hitherto unexplored characters of the female genitalia of the family for those species which I have available.

In the drawings to the male genitalia, the aedeagus has been omitted. This structure is remarkably uniform throughout the genus *Lepidostoma* and consists of a curved tube with a pair of dorsal sclerotized blades appressed to it. This structure offers some differences between certain species but presents no characters as striking as those exhibited by the claspers and tenth tergite. In previous papers I have referred to the sclerotized portion of the internal female genitalia as the bursa copulatrix. It seems much more logical to suppose that this sclerotized portion is part of the true spermatheca and is so termed in this paper.

The family is treated here as defined by Ross in 1944.

Types of new species described in this paper are deposited in the collection of the Illinois Natural History Survey, unless otherwise noted.

KEY TO GENERA

1. Head with posterior warts fairly wide, triangular or curved; 8th sternite of male without flap-like mesal processes; female with spermatheca either wide or ovate, figs. **20–34**, and with subgenital plate varied in structure but never with two pairs of membranous "horns" .... **Lepidostoma**
   Head with posterior warts long, narrow and straight; male with a long flat mesal flap on 8th sternite, fig. **37B**; female with spermatheca triangular, produced into a long apical point, figs. **35**, **36**, and with two pairs of membranous "horns" at the apex of the subgenital plate .... **Theliopsyche**

Genus **Lepidostoma** Rambur

The synonymy of this genus has been given by Ross (1944: p. 258). There the synonymy is listed without attempt to place the various names according to species groups. The generic names are listed here under the species groups in which they belong.

SYNOPSIS OF SPECIES GROUPS

Togatum Group.—Males with 10th tergite produced into a pair of simple arms arising laterally, and with claspers elongate, bearing a clavate basal process and a short pointed or cuneiform preapical process, the entire clasper arcuate from ventral view, figs. 1, 2; female with

spermatheca wide, fig. 20B, overlapped by or fused with its connecting folds and without a distinct sclerotized ventral bridge.

Includes *carolina*, *tibialis*, *knowltoni*, and *togatum*. To this group belong the genotypes of *Lepidostoma* Rambur, *Pristosilo* Banks, *Neuropsyche* Carpenter, and *Oligopsyche* Carpenter.

Latipennis Group.—Male genitalia with elongate claspers having a spatulate basal lobe, and a long sinuate mesal lobe, fig. 3. Female unknown. The position of this group is doubtful. *Latipennis* is the genotype of *Notiopsyche* Banks.

Cantha Group.—Male with elongate claspers bearing only a finger-like basal process; female with spermatheca fused with supporting bands but with a definite sclerotized ventral bridge, fig. 21. Contains only one species, *cantha*. The male genitalia are similar to the following group but the spermatheca is quite different.

Pluviale Group.—Males with elongate claspers bearing a finger-like basal process and a short subapical mesal process, 10th tergite usually armed with spines; female genitalia with spermatheca completely hidden beneath supporting folds, fig. 22, of an unusual bowl-like shape and with the ventral bridge near its apical margin. Contains *pluviale*, *rayneri*, and three new species described below.

Modestum Group.—Male genitalia having the basal process of the clasper elongate, overlaying the remainder of the clasper and expanded into a wide flat apex; female genitalia with spermatheca appearing suspended from ventral bridge, the spermatheca wide and somewhat triangular, fig. 23. Contains *modestum*, *swannanoa*, *lydia*, and *ontario*. *Modestum* is the genotype of *Atomyia* Banks.

Unicolor Group.—Male genitalia with short claspers exhibiting a great variety of shapes; female genitalia, figs. 24–26, having spermatheca ovoid and appearing suspended from ventral bridge; apical tergites without large areas of hair. Contains the largest number of species of any group. To this group belong the genotypes of *Nosopus* McLachlan, *Olemira* Banks, *Alepomyia* Banks, *Alepomyiodes* Sibley, *Arcadopsyche* Banks, and *Jenortha* Milne.

Vernalis Group.—Male genitalia various with 7th and 8th tergites, fig. 19, having large patches of long hair or 9th tergite with a large patch of setae, fig. 17; female genitalia with spermatheca as in the *Unicolor group*, but the 9th tergite with a pair of setal patches, fig. 34A. Contains *vernalis*, *griseum*, *sackeni*, *liba*, and *sommermanae*. To this group belong the genotypes of *Mormomyia* Banks and *Phanopsyche* Banks.

KEY TO NEARCTIC SPECIES

1. Maxillary palpi 1- to 3-segmented (males) 2
   Maxillary palpi 5-segmented (females) 35
2. Seventh and eighth tergites each with a pair of conspicuous ovate tufts of long hair, fig. 19; ninth tergite usually with a pair of hair tufts, fig. 17 3
   Seventh and eighth tergites with only scattered, well-separated hairs; ninth tergite never with hair tufts 7
3. Ninth tergite greatly enlarged and bulbous, fig. 19, overhanging lateral lobes of tenth tergite .... **sackeni**
   Ninth tergite short, as in fig. 17, lobes of tenth tergite connecting with its posterior margin 4

4. Ninth tergite with small hair tufts; tip of claspers narrowed and curved mesad; lateral lobes of tenth tergite large, their lower margin bearing two large sclerotized rods directed postero-mesad, fig. 17.............. **griseum**
   Ninth tergite with very large hair tufts; tip of claspers oblique; lateral lobes of tenth tergite small, without such processes (Ross, 1938*c*: fig. 90)........5
5. Mesal lobes of tenth tergite forming a pair of sclerotized outcurved rods (Ross 1938*c*: fig. 90); claspers with apical margin nearly transverse, serrate.. **vernalis**
   Mesal lobes of tenth tergite moderately large but membranous and inconspicuous (Ross 1941*b*: fig. 97A); claspers with apical margin decidedly oblique..6
6. Basal spur of clasper evenly curved and smooth, curving high above clasper base (Ross 1944: fig. 883).. **liba**
   Basal spur of clasper angled and serrate, fig. 18, rising only little above clasper base.. **sommermanae**
7. Front wings with entire costal cell reflexed, turned back over the rest of the wing so that it forms a flap covering at least the entire subcostal cell.......8
   Front wing with at most only a small basal portion of costal cell reflexed, or the reflexed area very narrow..14
8. Claspers short and thick, the apical lobes pointed (Betten 1934: pl. 64, figs. 1–5)...9
   Claspers long and slender, fig. 4, the apical lobes expanded................10
9. Lobes of tenth tergite with dorsal spur much longer than ventral spur, and projecting postero-dorsad, fig. 14........................... **americanum**
   Lobes of tenth tergite with dorsal spur shorter than ventral lobe and projecting antero-dorsad, fig. 15.................................. **costalis**
10. Lobes of tenth tergite with dorsal and ventral spurs fused to form an anchor-like structure, fig. 6.. **ornae**
    Lobes of tenth tergite with dorsal and ventral spurs well separated, fig. 4....11
11. Tenth tergite having the ventro-lateral spur forming a broad, flat, divergent flange, fig. 5.. **lotor**
    Tenth tergite having the ventro-lateral spur with only the sharp apex projecting laterad (Ross 1941*b*: fig. 95A)...............................12
12. Tenth tergite with ventral and dorsal spurs both small and apical (Ross 1941*b*: fig. 96)... **rayneri**
    Tenth tergite with ventral spur long, dorsal spur not at apex, either small (Ross 1941*b*: fig. 95) or large, fig. 4..................................13
13. Tenth tergite with upper portion of lobes projecting posterad, lateral aspect plate-like, dorsal aspect pointed, and bearing only an inconspicuous spur (Ross 1941*b*: fig. 95)...................................... **pluviale**
    Tenth tergite with upper portion of lobes projecting chiefly dorsad, and bearing a long spur on the back part, fig. 4......................... **rhino**
14. Claspers with dorsal process long, expanded at apex into an ovate lobe which overlies, or extends beyond, the apex of the main part of the clasper (Ross 1939*a*: figs. 9, 11)...15
    Claspers with dorsal process shorter, fig. 10, and usually pointed at apex, fig. 13..18
15. Tenth tergite with a pair of long flat arms, each arising at the side of the base of the tergite and extending in a sweeping arc beyond its tip; dorsal process of clasper long and stout, extending beyond remainder of clasper (Ross 1941*b*: fig. 98).. **ontario**
    Tenth tergite without definite lateral arms...............................16
16. Tenth tergite parallel sided, its apical margin with only a semi-circular mesal incision, the two apical lobes short and rounded laterad (Ross 1939*a*: fig. 9)... **lydia**
    Tenth tergite with apical portion elongate and tapering, with a mesal cleft nearly to base, (Ross 1939*a*: fig. 11)..................................17
17. Apical lobes of tenth tergite long, narrow, smooth, and whip-like (Ross 1938*a*: fig. 93).. **modestum**
    Apical lobes of tenth tergite wider and serrate along the margins (Ross 1939*a*: fig. 11)....................................... **swannanoa**
18. Base of tenth tergite with a pair of heavy ventral spurs, each arising at the lateral margin, curving beneath the tergite and then back, the spur tip

finally projecting from beneath the lateral margin of the tergite; claspers long and slender, with only a single process which is finger-like and projects dorsad from the base of the clasper (Ross 1941*b*: fig. 94)........**cantha**
Base of tenth tergite without such a pair of spurs; claspers frequently short and with two or three processes (Ross 1938*c*: fig. 92)....................19
19. Claspers with basal process very short, scarcely projecting above clasper base, fig. 13..**roafi**
Basal process of claspers projecting considerably above clasper body, figs. 3, 7, 10, 12, 16...20
20. Apex of claspers with a comb-like brush of spines chiefly dorsal in position, and a sinuate meso-basal process with an oval head, fig. 3; preapical process long and near middle of clasper. Wings very wide (Betten 1934: pl. 65, fig. 9)..**latipennis**
Apex of claspers with a dense brush ventral in position, figs. 7, 10; meso-basal process without head, figs. 7, 10; preapical process short and near apex of clasper..21
21. Tenth tergite divided into a pair of long, simple arms, with neither spurs nor sclerotized teeth (Ross 1938*a*: fig. 117); claspers with clavate basal process and a short mesal process at apex, figs. 1, 2....................22
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Togatum Group

The males of this group have few striking secondary sexual characters. The females of only two species have been associated with the males and these two are very similar in structure.

Lepidostoma togatum (Hagen)

1861. *Mormonia togata* Hagen, Syn. Neur. N. A. 273. ♀.
1897. *Silo pallidus* Banks, Am. Ent. Soc. Trans. 24: 29. ♂.
1899. *Pristosilo canadensis* Banks, Am. Ent. Soc. Trans. 25: 21. ♂.

The male considered as associated with Hagen's female type has been associated on the basis of certain characters of the venation, plus locality, as discussed by Ulmer and Betten. The latter (1934: pl. 65, figs. 1–8) gives excellent illustrations of the species. The female genitalia, fig. 20, are variable in detail but quite constant in general shape. The ventral bridge below the spermatheca is represented by only a membranous fold; in a few individuals this may be somewhat conspicuous and suggests very strongly that this membranous fold is the forerunner of the sclerotized ventral bridge found in some of the other groups.

The species is widely distributed throughout the central and eastern portion of the continent, with records available from the following localities: ARKANSAS—Mammoth Springs. CONNECTICUT—Mt. Carmel, Spruce Bank Spring. GEORGIA—Ringgold, Meadow Lake; Thomaston. KENTUCKY—Livingston, Rock Castle River. MAINE—Bingham; Warren. MICHIGAN—Brevort; Crawford Co., Au Sable River; Douglas Lake; Grayling, Manistee River. MISSOURI—Hollister; Waynesville. NEW YORK—Ithaca; Ogdensburg. NORTH CAROLINA—Cherokee. ONTARIO—Swansea; Thunder Bay. PENNSYLVANIA—Athens, Susquehanna River; Clinton Co., Kettle Creek. QUEBEC—Sherbrooke; St. Lawrence River. SASKATCHEWAN—Waskesieu Lake. TENNESSEE—Gatlinburg. WASHINGTON, D. C. WISCONSIN—Bloomer; Merril, Wisconsin River; Spooner, Namekagon River; Trout Lake.

Lepidostoma carolina (Banks)

1911. *Notiopsyche carolina* Banks, Am. Ent. Soc. Trans. 37: 356. ♂.

This species has been recorded only from the type locality of Southern Pines, North Carolina. Distinctive points of the male genitalia are illustrated by Ross (1938*c*: fig. 92); these drawings were made from a cleared preparation of a paratype. I have seen no females of this species.

Lepidostoma tibialis (Carpenter)

1933. *Neuropsyche tibialis* Carpenter, Psyche 40: 39. ♂, ♀.

To the illustrations in Carpenter's original description, I am adding a ventral view of the male clasper, fig. 1. The ventral mesal lobe of the clasper is represented in this species by only a broad shoulder. The female spermatheca is extremely similar to that of ***togatum***, differing

chiefly in that the dorsal sclerotized fold visible beneath the ninth tergite lacks any indication of the mesal trough characteristic of *togatum*.

The species has been taken only in the vicinity of the Great Smoky Mountain region. Available records include: GEORGIA—Lakemont. NORTH CAROLINA—Bryson City; Nantahala Gorge. TENNESSEE—Elkmont; Gatlinburg; Great Smoky Mountain National Park, Chimney's Camp Ground.

Lepidostoma knowltoni Ross

1938. *Lepidostoma knowltoni* Ross, Ill. Nat. Hist. Surv. Bull. 21: 175. ♂.

The twisted antennal scape and the ventral aspect of the clasper, fig. 2, readily identify this species. It is the only western species so far recorded for the group. No females have yet been identified and the species is known from only these three localities: COLORADO—Montezuma Co. MONTANA—Belton, along Flathead River. UTAH—Quinton.

Latipennis Group

This contains only a single species, *latipennis*.

Lepidostoma latipennis (Banks)

1905. *Notiopsyche latipennis* Banks, Am. Mus. Nat. Hist. Bull. 21: 216. ♂.

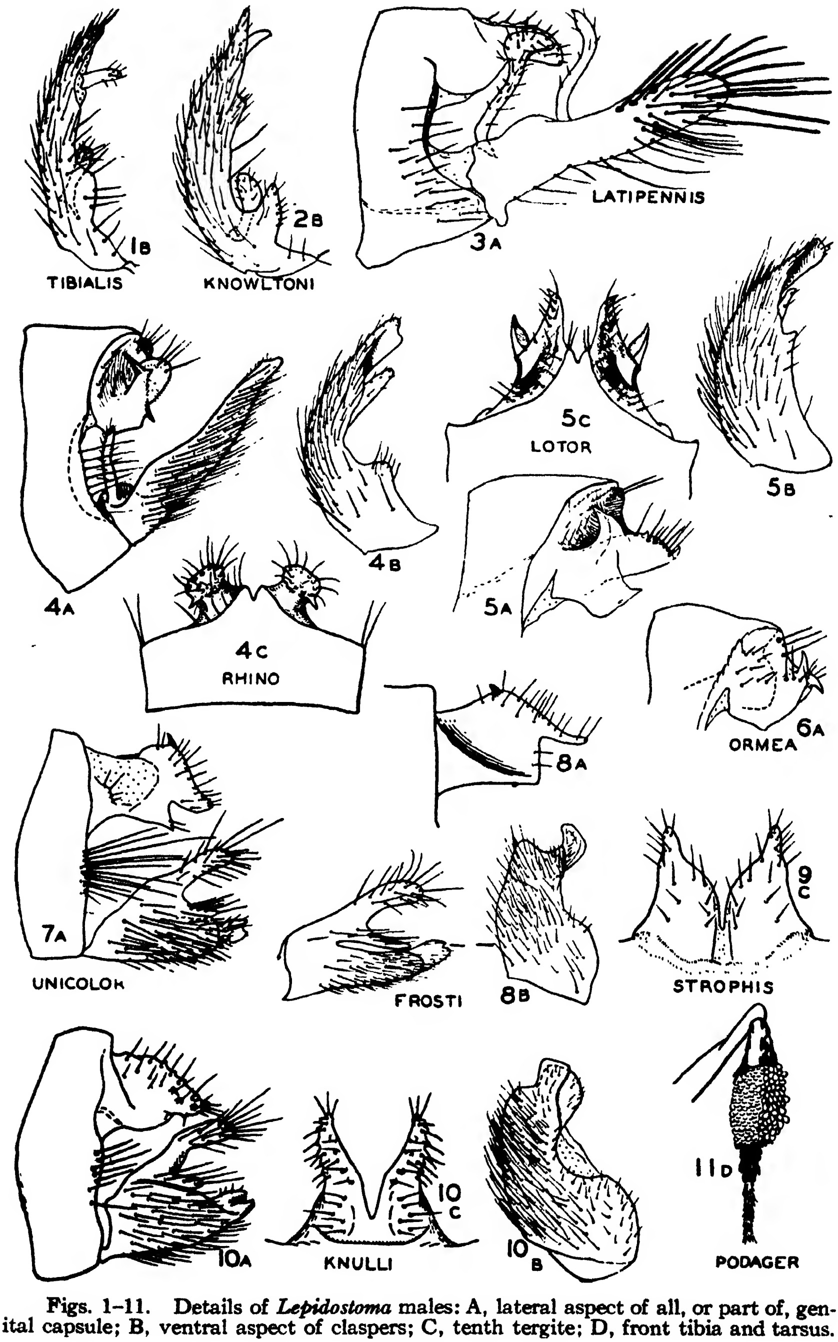
The unusually broad wing of the species illustrated by Banks in his original description and by Betten (1934: pl. 65, fig. 9), is a striking feature of the species. No less striking are the very unusual male genitalia, fig. 3. The tenth tergite is simple; the claspers have a very long, sinuate, capitate basal process and a second long sinuate mesal process arising near the middle. The apex of the clasper is surmounted by a brush of regularly placed, long setae; the ventro-lateral aspect of the clasper does not have the customary brush of hair. The maxillary palpi of the species are also of curious structure. In dried specimens they appear as a single-segmented, finger-like structure, but specimens preserved in fluid show that this is extensile, and may be extended into a long flexible tube, at least half as long as the antennae.

The female of this species has not been identified with certainty. An unidentified female from Georgia which may be this species suggests a close affinity with the *Togatum* group, but the association is not established.

The species is known from only scattered localities, as follows: GEORGIA—Roberta. NORTH CAROLINA—Black Mountain. NOVA SCOTIA—Chester Basin.

Cantha Group

This contains only one species, *cantha* Ross. The elongate simple clasper of the male genitalia suggests a close relationship with the *Pluviale* group, but the spermatheca is more suggestive of an intermediate condition between the *Togatum* group and the *Unicolor* group.



Figs. 1–11. Details of *Lepidostoma* males: A, lateral aspect of all, or part of, genital capsule; B, ventral aspect of claspers; C, tenth tergite; D, front tibia and tarsus.

Lepidostoma cantha Ross

1941. *Lepidostoma cantha* Ross, Am. Ent. Soc. Trans. 67: 118. ♂, ♀.

The spermatheca, fig. 21, distinguishes the female of this species from any others known in the genus. The body of the spermatheca merges imperceptably with its supporting bands and has a band-like ventral bridge. The ventral groove of the spermatheca is situated near the posterior margin and has an unusually long closed posterior portion.

The species is recorded only from the type locality, Hastings Natural History Reservation, Monterey County, California.

Pluviale Group

The males of all known members of this group have a greatly reflexed condition of the front wing. The anterior portion is very wide and is folded back over the top of the wing, covering a quarter to a third of its surface. The female spermatheca, fig. 22, is extremely peculiar for the genus, and sets off the group indubitably as the most distinctive in the genus. The connecting folds have extended anteriorly and have almost completely overlaid the spermatheca; there is a well marked ventral bridge at the end of these folds and it appears to be at the anterior end of the spermatheca instead of near or above the posterior end as in all the other groups of the genus. The male genitalia are characterized by a long slender clasper having a finger-like basal process, fig. 4. In this regard the *Pluviale* group resembles the *Cantha* group and it is interesting to note that the spermatheca of the *Cantha* group, fig. 21, would have to undergo little more than the migration of the ventral bridge to produce a structure somewhat like that in the *Pluviale* group.

The reflexed front wing presents one of the finest cases of parallel development in the entire family. This same condition was first observed in the species *americanum* and *costalis*, formerly placed in *Olemira*, and originally the members of the *Pluviale* group were also placed in *Olemira*. Both male and female genitalia of *americanum* and *costalis* show definitely that they are typical members of the *Unicolor* group, and that this superficial resemblance of the reflexed front wings is a case of parallel development without phylogenetic significance.

Lepidostoma pluviale (Milne)

1936. *Olemira pluviale* Milne, Studies N. A. Tric. 3: 117. ♂, ♀.

The male genitalia were illustrated by Ross 1941*b*: fig. 95. The female spermatheca is very similar to *rayneri*, no differences having been found to date to separate to species the females of this group.

This species appears to be restricted to the more eastern ranges of the western mountain areas in which it is the dominant member of the genus. The cases of the species appear to be always round and smooth, and of hard texture. I have reared the species on the basis of larvae and mature pupae collected together in many streams in the vicinity of Rocky Mountain National Park, Colorado.

In the original description of the species, a few specimens from British Columbia were listed as paratypes; these specimens do not

belong to this species but to *rayneri*. Rechecked available records of *pluviale* are listed below: COLORADO—Rocky Mountain National Park, Cascade Lodge; Estes Park, Thompson River; West Creek; Granby, Fraser River; Creede. MONTANA—Belton, Flat Head River; Glacier National Park, Logging Creek; Harrison. WYOMING—Jenny Lake, Grand Teton National Park; Green River, north of Pinedale. UTAH—Logan; Brigham Canyon; State Lake County, Mill Creek.

Lepidostoma rayneri Ross

1941. *Lepidostoma rayneri* Ross, Am. Ent. Soc. Trans. 67: 117. ♂, ♀.

The spermatheca of this species is illustrated in fig. 22. There is some variation in its exact shape and the sclerotized piece which proceeds posteriorly from the meson of the ventral bridge. At the anterior end of the spermatheca, there is a somewhat oval membranous fold which varies considerably in shape and definition.

Few records are available for this species, but it appears to replace *pluviale* in the Coastal and Cascade ranges of the western mountains, with records from the following: BRITISH COLUMBIA—Cultus Lake; Lillooet. CALIFORNIA—Mono County, Convict Creek. OREGON—Molalla, Molalla River. WASHINGTON—Cashmere, Wenatchie River.

Lepidostoma ormea n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Color brown, legs and venter a lighter shade than the dorsum; antennae and palps very light brown. Wings uniformly infuscate with very light brown. Maxillary palpi appearing one segmented, short and thumb-like, surmounted by an eversible membranous lobe bearing a brush of dense black hair. Antennal scape nearly as long as width of head, the anterior (ventral) margin concave and bearing a dense brush of long yellow hair and shorter black scales. Front wing with the costal and sub-costal cells greatly expanded to form a large flap extending from the base of the wing to the stigma, the flap folded over on to the dorsal surface of the wing and forming a flat pouch which extends back to and overlaps radial sector. The pouch is filled with a series of scales.

Genitalia, fig. 6A, similar in general structure to *rayneri*. Tenth tergite forming a pair of divergent lobes, each bearing at apex a strongly developed spined hook, one spine projecting dorsad, the other ventrad. There is no lobe which extends posterior to these spines. Claspers elongate, with a basal finger-like process, very similar to those in fig. 4A.

Holotype, male.—Heber City, Utah, July 23, 1939, at light, Knowlton and Harmston.

This species is most closely related to *rayneri*. In this latter species the apex of the tenth tergite forms a wide lobe with a dorsal spine and a ventral spine which are well separated. In *ormea* these two spines have apparently come together and fused to form a single anchor-like hook.

Lepidostoma lotor n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Color very dark brown, almost black, with legs, palpi, and venter of abdomen

slightly lighter. Wings moderately dark brown, the reflexed scale pocket dark brown and approaching the color of the dorsum. General structure of palpi, flagellum, and wings as described above for *ormea*.

Genitalia, fig. 5, typical in general shape for group. Tenth tergite divided into a pair of lobes, figs. 5A and C, each lobe bearing near the middle a large dorsal flange-like spur, and, below it, a wide projecting flange with a posterior point. The main portion of the lateral lobe is produced posteriorly into a moderately long pointed structure bearing a dorsal row of setae and a small sclerotized point at its tip. Claspers very similar to fig. 4A, from lateral view; ventral aspect broad, fig. 5B, the apical third tapering rapidly to the tip.

Holotype, male.—Wadell Creek, California, May 15, 1937.

Differences given in the key separate this species from its allies.

Lepidostoma rhino n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Color of head and body medium shades of brown; antennae, palpi, and legs, tawny; wings infuscate with yellowish. General structure of scape, palpi, and wings as described above for *ormea*.

Genitalia, fig. 4, with tenth tergite divided into a pair of lateral lobes, each bearing on the lateral side a long antero-dorsal and a shorter ventral spine, the lobe beyond these spines forming a rounded crown; from dorsal view these lateral lobes appear somewhat button-like, fig. 4C. Claspers elongate with a finger-like baso-dorsal lobe; their ventral aspect, fig. 4B, has the basal third wide, beyond which it narrows suddenly and the apical two-thirds curves more or less evenly to the apex.

Female.—Size and general color typical for male. Structure of palpi and wings simple, as for females of other members of the genus. Spermatheca similar to that of *rayneri* (fig. 22B); no distinguishing features have been found to date to separate to species the females of this group.

Holotype, male.—R. Santo Domingo, Rancho San Antonio, 1000 feet elevation, Baja California, Mexico, May 24, 1937, H. J. Rayner.

Allotype, female.—Same data as holotype.

Paratypes.—4 ♂, 4 ♀, same data as holotype.

Differences given in the key separate this species from its allies.

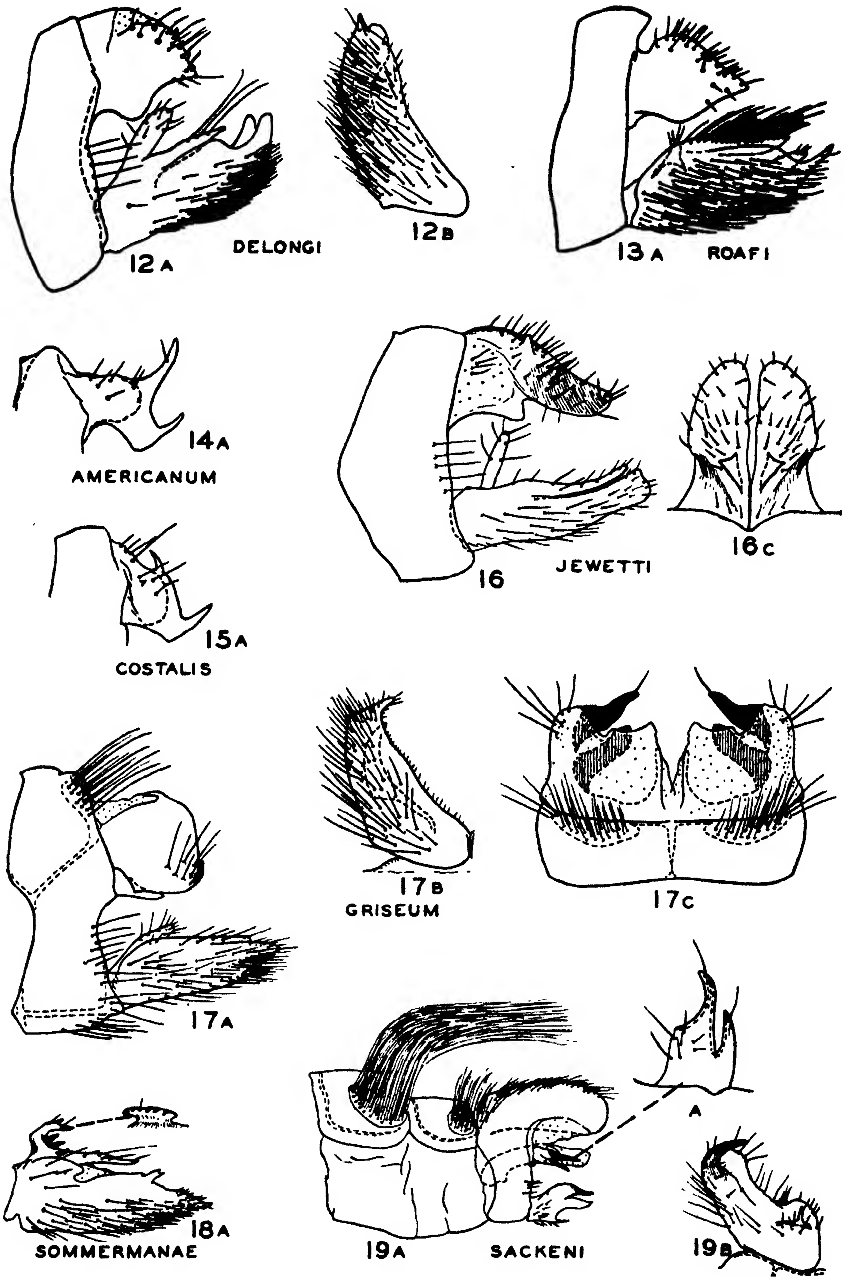
Modestum Group

This group is set off very clearly from others in the genus by the wide, sub-triangular spermatheca of the female, fig. 23B, and the dorsal process of the claspers, which is expanded at the apex, (Ross 1939*a*: fig. 11). Four species described to date belong in this group.

Lepidostoma modestum (Banks)

1905. *Atomyia modesta* Banks, Am. Mus. Nat. Hist. Bull. 21: 217. ♂.

This species has not been recorded since its original description. A more complete description, with illustrations, was presented soon after the original description by Banks (1905: page 12, figs. 21–25). The lobes of the tenth tergite of the male end in a long whip-like tip, illus-



Figs. 12–19. *Lepidostoma*, male genitalia: A, lateral aspect of all or part of capsule; B, ventral aspect of claspers; C, dorsal aspect of tenth tergite.

trated by Ross (1938*c*: fig. 193). Other parts of the genitalia and various adult structures are illustrated by Betten (1934: pl. 62, figs. 1–7). The female of the species has not yet been definitely associated.

Lepidostoma swannanoa Ross

1939. *Lepidostoma swannanoa* Ross, Ent. Soc. Wash. Proc. 41: 69. ♂, ♀.

There is a possibility that this may eventually prove to be the same as *modestum*. The only difference found to date is in the shape of the lobes of the tenth tergite, but the difference seems to be striking and distinctive in the material I have examined. It is unusual, however, that subsequent collecting at Black Mountain, North Carolina, the type locality of both *modestum* and *swannanoa*, has resulted in the capture of only *swannanoa* and it may well be that eventually intergrades may be found which might link these two forms which now appear distinct. The female of *swannanoa* is very similar to that of *ontario*, and the spermatheca appears to differ only in variable details from that illustrated in fig. 23B.

Records of *swannanoa* are scattered almost the length of the Appalachian region, as follows: New Hampshire—Benton, Moosilanke Lake; Glen House, Mt. Washington; Woodstock. New York—Adirondack Park, Euba Mills and Blue Mountain Lake. North Carolina—Black Mountain.

Lepidostoma lydia Ross

1939. *Lepidostoma lydia* Ross, Ent. Soc. Wash. Proc. 41: 70. ♂, ♀.

The female of this species is very similar to others in the group, the spermatheca resembling very closely that of *ontario*. This distinctive species appears to have a somewhat similar distribution to that of *swannanoa*, the records being scattered along the length of the Appalachian system: New Hampshire—Mt. Washington, at Avalanche Creek, Crawford Notch, Cog Railway, Gibbs Brook, Glen House & Pinkham Notch Camp; Warren; Woodstock. New York—West of Keene, Adirondack Park. Virginia—Lydia.

Lepidostoma ontario Ross

1941. *Lepidostoma ontario* Ross, Am. Ent. Soc. Trans. 67: 119. ♂, ♀.

The spermatheca of the female, fig. 23B, is roughly trianguloid in shape, but varies considerably in details of shape and proportions.

Records are available only for Ontario and New Hampshire, as follows: New Hampshire—Benton, Witcherville Brook; Mount Washington, Cog Railway, Gibbs Brook; Randolph; Woodstock, along Bog Brook and Pemigewasset River. Ontario—Algonquin Park, Costello Lake.

Unicolor Group

In this and the following group, the spermatheca is longer than wide, usually egg shaped and appears suspended from the end of the ventral bridge, figs. 24–26. In the *Unicolor* group the ninth tergite has only scattered hair, whereas in the *Vernalis* group this area has a

pair of definite setal patches. In the *Unicolor* group the females exhibit a wide variety of shapes of the ninth and tenth tergites and also of the spermatheca. Of the 14 species here included in this group, 7 have definitely associated males and females. All seven of these show excellent diagnostic differences and it is highly probable that, when identified, the females of many of the remaining 7 species will lend themselves to specific diagnosis.

The males of the group are characterized chiefly by the short claspers. The only notable exception to this is the species *jewetti*. The female of this latter species is not known so that its placement in this group must be considered tentative.

Lepidostoma unicolor (Banks)

1911. *Mormomyia unicolor* Banks, Am. Ent. Soc. Trans. 37: 357. ♂.

The wings of the male have an abundance of black scales mixed with the hair. The male genitalia, fig. 7A, have the lobes of the tenth tergite armed with a dorsal spine; and the postero-ventral region of each lobe is divided by a deep cleft into two sharp lobes. The clasper has the basal process stout and angled or curved forward over the body of the clasper and the dorsal process appears to branch from it; the apex is produced into a broad pad which appears somewhat button-like from lateral view.

The female has the simple type of head structures and wings typical for the genus. The ninth tergite, fig. 27A, is broad, without deep impressions, the tenth tergite is only slightly incised on meson and forms a broad semimembranous plate; the membrane forming the under side of the tenth tergite bears a sclerotized mesal thickening which ends in a round sclerotized area. The spermatheca is very similar to that illustrated in fig. 24B.

The type of clasper found in this species is characteristic of four species, which form a fairly definite complex: *unicolor*, *frosti*, *strophis*, and *knulli*.

Unicolor is widely distributed through the Rocky Mountain region. Apparently it also extends eastward through the northern part of the continent as indicated by records from Saskatchewan and Minnesota. Specimens have been examined from the following localities: BRITISH COLUMBIA—Vancouver. CALIFORNIA—Inyo County; Mono County, Convict Creek, Roads End; San Gabriel Mountains, Switzer's Camp. COLORADO—Buena Vista, Cottonwood Creek; Colorado Springs, Seven Falls Creek; Green Mountain Falls, Crystal Creek; Rocky Mountain National Park. IDAHO—Pope, Trestle Creek. MINNESOTA—Duluth. SASKATCHEWAN—Reindeer Lake. UTAH—Blacksmith Fork Canyon; Greenvine; Kamas; Logan; Lake Point; Whiterocks. WYOMING—Yellowstone National Park, Lewis River.

Lepidostoma frosti (Milne)

1936. *Atomyia frosti* Milne, Studies N. A. Tric. 3: 119. ♂, ♀.

The tenth tergite of the male, fig. 8A, is produced into a slender finger-like process projecting above a very angular ventral portion;

each lobe has a definite sclerotized spur on its dorsal margin. The clasper, fig. 8B, has the basal and dorsal processes forming a distinct Y from lateral view. I have no large collections of this species available and hence have been unable to associate with certainty the female and male.

Present records of the species are restricted to the northeastern area, with records for Pinkham and White Mountains, New Hampshire, and Knowlton, Quebec.

Lepidostoma strophis Ross

1938. *Lepidostoma strophis* Ross, Ill. Nat. Hist. Surv. Bull. 21: 177. ♂.

The female of this species has the ninth and tenth tergites similar in most respects to *quercina*, illustrated in fig. 29A and C. In *strophis* the spermatheca is distinctive; the ventral bridge flares out considerably beyond the sides of the spermatheca and is situated so that it lies at the top of or above the spermatheca, fig. 24B.

The species is transcontinental in distribution with records scattered from Maine to the Pacific coast. The following records are available: BRITISH COLUMBIA—Cultus Lake; N. of Ft. St. James, Middle River at Takla Lake; Vernon (1 ♂ paratype of *roafi*, INHS). CALIFORNIA—Mono County, Hot Creek. COLORADO—Gould. MAINE—Double Top Mountain, Sourdnahunk River. MICHIGAN—Montmorency County, Hunt Creek; Beulah. MONTANA—Hamilton. OREGON—Corvallis, Dixon Creek; Foster, Santiam River; Klamath Lake, Barkley Springs; Tidewater. UTAH—Providence.

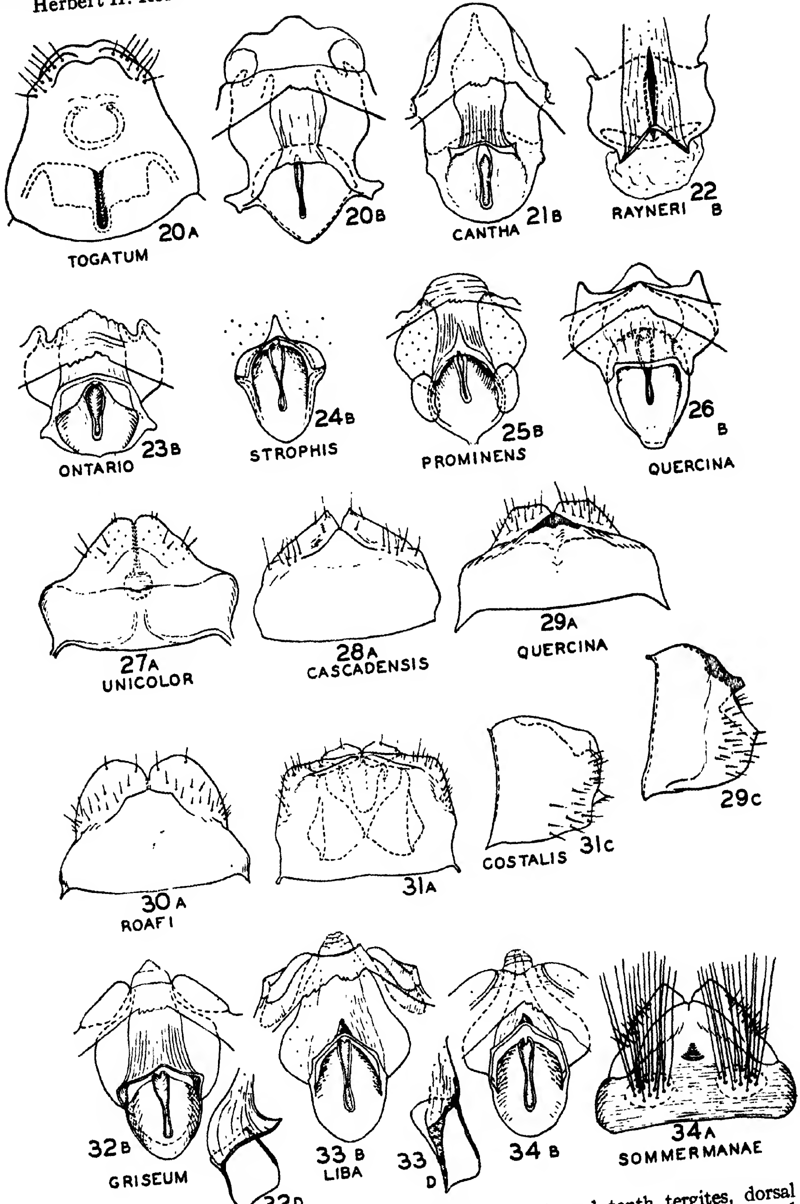
Lepidostoma knulli n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Body color medium brown with the venter of the abdomen, legs, and palpi lighter. Wings light brown, the wings with hair but without patches of scales. Basal segment of antenna subequal in length to greatest length of eye. Maxillary palpi short and spatulate, usually held together to form a mask in front of the face. Wings without scale pockets or peculiarities of venation.

Genitalia as in fig. 10. Ninth segment short and almost annular. Tenth tergite forming two widely separated lobes, each studded with small protuberances, with a seta arising at the base of each; the arms proceed slightly laterad, but the tips recurve slightly mesad. Claspers with basal process long and stout, curving posterad above the clasper and subequal in length to the body of the clasper; the dorsal process is short and appears to arise from the base of the basal process; the tip of the clasper is divided into two thick wide lobes, of which the dorsal one is rounded and the ventral one truncate from ventral view, fig. 10B.

Holotype, male.—Oak Creek Canyon, Arizona, Aug. 15, 1938, D. J. & J. N. Knull.

This species is most closely related to *strophis*, differing in the shape of the lobes of the tenth tergite and the shorter dorsal process of the claspers.



Figs. 20–34. *Lepidostoma*, female genitalia: A, ninth and tenth tergites, dorsal aspect; B, spermatheca and subgenital plate, ventral aspect; C, ninth and tenth tergites, lateral aspect; D, spermatheca, lateral aspect.

Lepidostoma podager (MacLachlan)

1871. *Nosopus podager* McLachlan, Linn. Soc. London Jour. 11: 116. ♂.

The genitalia of this species are almost exactly as illustrated for *quercina* (Ross 1938*a*: p. 176). In *podager* the tibia and basitarsus of the front legs, fig. 11D, and the maxillary palpi are greatly expanded and leaf-like, covered by a dense brush of scales. I have seen no females of this species, but Milne (1936) indicates that it is of the usual simple *Lepidostoma* type and superficially very similar to *roafi*. It is probable that a detailed study of this female will indicate close similarities to the figures here given for *quercina*. The species was originally described from California and has been recorded since from no other state. I have seen only paratypes of MacLachlan's species and a series from San Geronimo, both in the collection of the Museum of Comparative Zoology.

The pointed apex of the claspers (as in figs. 12, 13) of this species is typical of a fairly large complex including *podager*, *quercina*, *cascadense*, *roafi*, *bryanti*, *prominens*, *delongi*, and the two species formerly considered in *Olemira*, namely, *americanum* and *costalis*.

Lepidostoma quercina Ross

1938. *Lepidostoma quercina* Ross, Ill. Nat. Hist. Surv. Bull. 21: 176. ♂.

As pointed out in the original description, the male genitalia of this species are practically identical with those of *podager*. The legs and mouthparts, however, are slender and quite normal. The species was originally described from a single male. Subsequent collections very kindly sent to me by the staff of Oregon Agricultural College, Corvallis, Oregon, have contained considerable additional material of this species, including associated males and females. In all these the legs and palpi are simple in structure, showing no tendency to the enlargement of these parts which is characteristic of *podager*. The female is relatively stout bodied, compared to other members of the genus. Its ninth and tenth tergites, fig. 29A and C, are short; the ninth tergite forms a darkened angulation at the apex, the tenth tergite forms a pair of wide, well separated lobes which are truncate at the apex. The spermatheca, fig. 26B, is ovoid, tapering at its free end; the ventral bridge is well marked and situated so that it crosses the spermatheca considerably lower than in most of the other species.

To date records are available only from Oregon, as follows: Benton County, Rock Creek and north fork of Alsea River; Clatsop County, Big Creek; Corvallis, Oak Creek; Philomath, Woods Creek; Silver Creek Falls.

Lepidostoma cascadense (Milne)

1936. *Jenortha cascadensis* Milne, Studies N. A. Trich. 3: 119. ♂.
1938. *Lepidostoma pleca* Ross, Ill. Nat. Hist. Surv. Bull. 21: 175.

In this species the antennal scape has a strong lateral process and the basal tenth of the costal cell is reflexed to form a conspicuous scale filled pocket. These peculiarities form the basis of the genus *Jenortha* Milne, of which the species is the genotype. The male genitalia have been illustrated by Ross (1938*a*: p. 176) in the original description of

the synonym *Lepidostoma pleca.* Female spermatheca is very similar to that of *strophis* (fig. 24), but the sides of the ventral bridge are not flared out as in that species. The ninth and tenth tergites of *cascadense*, fig. 28, are diagnostic for the species, the ninth tergite forming a moderately sharp apex, the tenth tergite divided into well marked submembranous lobes which taper to a pointed apex separated by a V-shaped fissure.

The two previous descriptions involving this species were based on records from British Columbia and Washington. Since then additional material has shown that the species is widely distributed throughout the entire Rocky Mountain area. It has been taken along a wide variety of streams but all of them are cold and rapid, most of them of the true mountain cascades. Records are available for the following localities: BRITISH COLUMBIA—Vancouver, Mosquito Creek, Capilano River; Whonnock, Whonnock Creek. CALIFORNIA—Tuolumne County, Yosemite National Park, Tuolumne River. COLORADO—Buena Vista, Collegiate Peaks; Cascade Lodge; Estes Park; Green Mountain Falls, Crystal Creek; Rocky Mountain National Park, Thompson River. IDAHO—Pope, Trestle Creek. MONTANA—Dutch Creek; Sprague County; Roe's Creek; Trick Falls Creek; all in Glacier National Park. WASHINGTON—Suitan, Anderson Creek.

Lepidostoma delongi n. sp.

Male.—Length from front of head to tip of wing, 9 mm. Color dark brown, the legs and palpi slightly lighter. Wings uniformly stained with light brown. General structure typical for genus. Maxillary palpi with only indistinct segments, and forming a brush which is longer than the scape, densely clothed with long scales and somewhat plume-like in general appearance. Antennal scape as long as width of head, slender and cylindrical, with only a shallow ventral groove filled with scales. Front wings with neither scale pockets nor other unusual features.

Male genitalia, fig. 12, with ninth segment nearly annulate, separated from tenth by fairly distinct furrows. Tenth tergite divided into a pair of deep lobes, each with a few sclerotized teeth on the dorsal side of the apical portion, and with a scattering of setae over the dorsal region. Claspers, fig. 12B, short, the base having a fairly long basal process and a longer tapering dorsal process; apex of clasper with ventral lobe tapering to a sharp point, dorsal lobe rounded.

Holotype, male.—Zitacuara, Mexico, at light, 1941, D. M. DeLong.

On the basis of genitalia, this species most closely resembles *cascadense* but differs from it in the deep and plate-like lateral aspect of the lobes of the tenth tergite. It differs also in the simple antennal scape.

Lepidostoma prominens (Banks)

1930. ***Arcadopsyche prominens*** **Banks, Brook. Ent. Soc. Bull. 25: 129. ♂.**

This species is readily distinguished in the male by the two long spur-like ventral processes of the tenth tergite (Ross 1938*c*: fig. 91). This latter drawing was made from a paratype male kindly made available to me by Mr. Nathan Banks, Museum of Comparative Zoology. The female is readily distinguished by the spermatheca,

which bears on each side a ventral ear-like expansion which appears to be attached at the juncture of the ventral bridge and spermatheca, fig. 25.

The species was described from Cape North, Cape Breton, Nova Scotia. Another record is available from Grand Lac Jacques Cartier, Laurentian National Park, Quebec.

Lepidostoma bryanti (Banks)

1908. *Alepomyia bryanti* Banks, Psyche 15: 65. ♂.
1909. *Lepidostoma wisconsinensis* Vorhies, Wisc. Acad. Sci. Arts & Letters Trans. 16: 685. ♂.

The male of this species has been well illustrated by Banks and Vorhies in the original descriptions cited above and also by Betten (1934: pl. 62, figs. 10, 11; pl. 63, fig. 1). I have no females positively associated with the males of this species. Only a few records are available for this species but they are scattered over a wide area of the northern and eastern states, as follows: NEWFOUNDLAND—Grand Lake. NEW YORK—Old Forge. PENNSYLVANIA—Monroe County. WISCONSIN—Devil's Lake and Parfrey's Glen (near Madison).

Lepidostoma roafi (Milne)

1936. *Atomyia roafi* Milne, Studies N. A. Tric. 3: 120. ♂, ♀.

The male of this species is distinguished from all its allies by the shape of the lobes of tenth tergite and claspers, fig. 13. The clasper has only a short basal process which just barely extends to the dorsal level of the clasper; the dorsal process is very long and extends to within a short distance of the pointed tip of the clasper. The female is readily distinguished by the combination of the spermatheca, which resembles very much that of *prominens* (see fig. 25) without the "ears," and the structure of the ninth and tenth tergites, fig. 30. The ninth tergite is of moderate length and produced into a slightly angulate area. The tenth tergite forms two large ovate semi-membranous lobes separated by a distinct notch on the meson.

The species is apparently widely distributed through the Rocky Mountain region, with definite records for the following: BRITISH COLUMBIA—Vancouver. CALIFORNIA—Convict Creek, Mono County. COLORADO—Buena Vista, Collegiate Peaks; Cameron Pass; Crystal Creek, Green Mountain Falls; Colorado Springs, Seven Falls Creek; Eagle County; Gothic; Pingree Park; Science Lodge, Boulder County. MONTANA—Elliston. WASHINGTON—Dewatto. WYOMING—Wilson, Coal Creek.

In the original description of the species, Milne lists Oregon as one of the paratype localities. In the paratype series, there is a mixture of both *roafi* and *strophis* and the only one of these that I have seen from Oregon is a specimen of *strophis*. Although the species undoubtedly occurs in Oregon, there seems no definite record of it as yet from that state.

Lepidostoma americanum (Banks)

1897. *Olemira americanum* Banks, Am. Ent. Soc. Trans. 24: 29. ♂, ♀.

The male characters have been well described by Betten (1934: pl. 64, figs. 1–5). In general structure this species is very similar to

the following, *costalis*, differing chiefly in the very long dorsal spur of the lobes of the tenth tergite, fig. 14. I have not examined females of this species. *Mormonia pictilis* Banks, described from a single female, has frequently been listed as a synonym of *americanum*. Until distinguishing characters are worked out to identify to species more females in the genus, it seems better to list *pictilis* as an unplaced species.

Originally described from Sea Cliff, New York, it has since been reported by Banks from Manitoba and Virginia. Recently I have received a record of it from Neel Gap, Georgia.

Lepidostoma costalis (Banks)

1914. *Olemira costalis* Banks, Can. Ent. 46: 265. ♂.

The males of this species have been illustrated by Banks in the original description and by Betten (1934: pl. 63, fig. 4; pl. 64, figs. 1–5). A detail of the diagnostic characters of the tenth tergite is given in fig. 15. The female has a very massive development of the ninth tergite, fig. 31, which overlaps the small semi-membranous lobe of the tenth tergite. The spermatheca is similar in general to that of *prominens*, fig. 25, but lacks the "ears."

This species has been recorded from various localities from the northeast, as follows: MAINE—Mt. Katahdin, Togue Pond; New Limerick, Hunter Brook. MICHIGAN—Montmorency County, Hunt Creek. NEW YORK—Ogdensburg; Fulton County. ONTARIO—Costello Lake, Algonquin Park.

Lepidostoma jewetti n. sp.

Male.—Length from front of head to tip of wing, 10 mm. Color brown, the venter and appendages lighter. Wings only slightly darkened. General structure typical for genus. Maxillary palpi short and finger-like, only half the length of the scape and clothed with loose brushy hair. Antennal scape cylindrical, about as long as the width of the head, its mesal side bearing a shaggy brush of scales and hair which extends the entire length of the scape. The front wings with basal fifth of costal cell reflexed and folded back over dorsum of wing to form a scale pocket; both front and hind wings with rows or patches of black scales along radial sector veins and cells posterior to it.

Male genitalia as in fig. 16. Ninth segment almost annular, separated from tenth tergite by a definite crease. Tenth tergite divided into a pair of fairly long lobes which are almost parallel, in dorsal view rounded at the tip, from lateral view somewhat snout-like with a distinct elevation near dorsum and a sharp incision on the ventral margin. Claspers of moderate length, with a fairly long finger-like basal lobe and a long slender mesal lobe which is appressed to, and nearly as long as, the body of the clasper. The apex of the clasper is not subdivided into definite folds but is quite thin, appearing wide and truncate from lateral view and almost linear from ventral view.

Holotype, male.—Ellsworth, Washington, May 15, 1941, S. Jewett, Jr.

The undivided apex of the clasper separates this species immediately from all other members of the *Unicolor* group, and other features of the

clasper distinguish it from all other Nearctic members of the genus. The species is sufficiently distinct that it could well form a subgroup or distinctive group of its own. The female is unknown; when discovered, its structure will undoubtedly assist in a more definite group placement of this species.

Vernalis Group

To this group belongs a heterogenus complex of species which are similar in many features to the *Unicolor* group but have patches of long setae developed on some of the apical tergites. Of these the species *griseum* is very similar to members of the *Unicolor* group, in particular the complex containing *roafi* and *bryanti*. It is undoubtedly a linking form between these two groups. Of the remaining species in the group, *vernalis* and *sackeni* are extremely distinctive, and *liba* and *sommermanae* together form a small but equally distinctive complex.

Lepidostoma griseum (Banks)

1911. *Phanopsyche griseum* Banks, Am. Ent. Soc. Trans. 37: 357. ♂.

This species is similar to many members of the *Unicolor* group in structure of the claspers, but differs from them in the cushions of setae on the apical tergites. On the sixth, seventh, and eighth segments these setal cushions are only a little larger than those on the ninth tergite, fig. 17, but the hairs are longer and form erect brushes. Many features of the adult structure, including venation and the male genitalia, are illustrated by Betten (1934: pl. 64, figs. 6–12). Additional details of the male genitalia are given here in fig. 17. The female spermatheca, fig. 32, is surmounted by a ventral bridge which flares considerably ventrad of the spermatheca itself.

This species is distributed through several northern and eastern states and Ontario, as follows: MICHIGAN—Montmorency County, Hunt Creek. NEW JERSEY—Milltown. NEW YORK—McLean; Ogdensburg; Woodworth's Lake, Fulton County. ONTARIO—Algonquin Park, Costello Lake. PENNSYLVANIA—Columbia Cross-Roads. TENNESSEE—Gatlinburg.

Lepidostoma sommermanae n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Color dark brown, the appendages and venter yellowish brown to tawny, scape of antennae short, subequal in length to mesal length of head, clothed with short scattered hair. Maxillary palpi finger-like, short, the inner surface bare, the outer surface clothed with a brush of dark hair. Legs and wings without special modifications, similar in most respects to those of the females.

General structure and proportions of genitalia as illustrated by Ross (1941*b*: fig. 97) for *liba*. Ninth segment annular, with a pair of large cushions of hair, one on each side of the meson. Tenth tergite divided into a pair of lateral sclerotized arms and a mesal pair of inconspicuous membranous lobes. Clasper, fig. 18, with lateral aspect irregular, tapering to a point, with the dorsal process slender and pointed, curving mesad into an irregular process bearing several stout spines; this spined area appears as a flange-like projection from caudal view.

Female similar in size and general color to male. Ninth tergite large, produced into a long dorsal portion and with a pair of hair cushions on either side of the meson near base, fig. 34A. Tenth tergite forming two more or less triangular lobes separated on the meson by a wide fissure. Spermatheca, fig. 34B, ovate, with a definite ventral bridge which in profile does not project ventrad of the profile of the spermatheca. Subgenital plate with mesal portion definitely sclerotized, lateral area membranous.

Holotype, male—Mt. Carmel, Connecticut, Woodruff's Pond, May 15, 1944, Mrs. A. H. Sommerman.

Allotype, female.—Mt. Carmel, Connecticut, September 4, 1944, Mrs. A. H. Sommerman.

Paratypes.—CONNECTICUT—Mt. Carmel, Spruce Bank Spring, June 26, 1944, Mrs. A. H. Sommerman, 1 ♂; Sept. 4, 1944, 1 ♀. PENNSYLVANIA—Roxboro, June 28, 1♂; Aug. 15, 1909, Haimbach, 1 ♂ (ANSP).

This species was collected as larvae and subsequently reared by Mrs. Sommerman in a small springfed brooklet at Mt. Carmel. The cases which she obtained were all of the round stone type and the observations on their habits correspond closely with those observed for *liba*. Betten illustrated the clasper of this species (1934: p. 401, pl. 62, figs. 8, 9) under the name *Mormomyia vernalis*. Dr. Betten very kindly loaned me the preparation of his material to aid in verifying its identity.

The species is a close relative of *liba*, differing chiefly in the subgenital plate of the female and the basal process of the male clasper.

Lepidostoma liba Ross

1941. *Lepidostoma liba* Ross, Am. Ent. Soc. Trans. 67: 120. ♂, ♀.

Since the original description, the larva and habitat preference of this species has been discussed by Ross (1944: p. 259). The species has not yet been recorded outside of Illinois where it occurs in a few isolated springfed streams. In the original description the illustration of the spermatheca lacks much detail and a revised drawing is presented in fig. 33.

Lepidostoma vernalis (Banks)

1897. *Mormonia vernalis* Banks, Am. Ent. Soc. Trans. 24: 29. ♂, ♀.

The male genitalia of this species have been illustrated by Ross (1938*c*: p. 90), from a paratype. The species is one of the most striking in the genus. I have seen no females of this species or *sackeni*.

The species was described from Sea Cliff, New York, and later recorded by Banks from Tyron, North Carolina. Dr. Betten has loaned me an additional male from McLean, New York.

The illustrations given by Betten under the name *Mormomyia vernalis* (1934: p. 401, pl. 62, figs. 8, 9), represents *sommermanae*.

Lepidostoma sackeni (Banks)

1936. *Mormomyia sackeni* Banks, Arb. Morph. Tax. Ent. aus Berlin-Dahlem 3: 267. ♂.

To the illustrations given by Banks in the original description, I am adding illustrations of a few details of the male genitalia, fig. 19. These

drawings are made from a paratype kindly loaned to me from the Museum of Comparative Zoology by Mr. Banks. As pointed out by Banks, the extremely bulbous ninth tergite distinguishes this species immediately from all others in the genus. The lateral lobes of the tenth tergite are sclerotized biramous structures and situated in the middle of the lateral aspect of the segment, fig. 19A.

Lepidostoma (species of uncertain status)

The following species of *Lepidostoma* are known only from females. I have not examined their genitalia so that it is impossible at the present time to be certain of their placement.

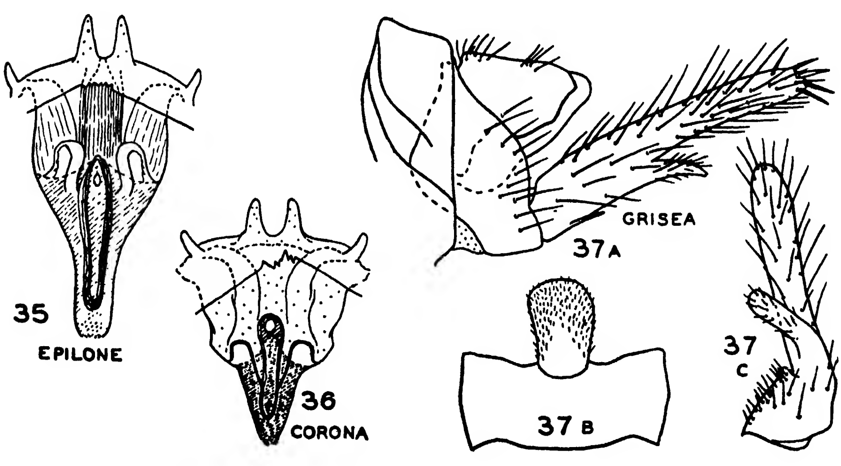
Silo cinereum Banks, 1899, Am. Ent. Soc. Trans. 25: 210. Described from California.

Thremma deceptiva Banks, 1907, Wash. Ent. Soc. Proc. 8: 125. Described from New Mexico.

Lepidostoma stigma Banks, 1907, Wash. Ent. Soc. Proc. 8: 125. Described from Colorado.

Olemira mexicana Banks, 1901, Am. Ent. Soc. Trans. 27: 367. Described from Mexico.

Mormonia pictilis Banks, 1899, Am. Ent. Soc. Trans. 25: 211. Described from Franconia, New Hampshire. This species has sometimes been listed as a synonym of *americanum.*



Figs. 35–36. *Theliopsyche*, female spermatheca and subgenital plate, ventral aspect. Fig. 37. *Theliopsyche*, male genitalia: A, lateral aspect; B, eighth sternite; C, left clasper, ventral aspect.

Genus **Theliopsyche** Banks

In addition to characters of the warts on the head, this genus is readily distinguished from *Lepidostoma* by the broad mesal plate-like process of the eighth sternite of the males, fig. 37B, and by the elongate,

triangular spermatheca of the female. The female has been associated with only two of the four species but in each case, figs. 35, 36, the ventral elliptic ridge is much wider and larger than in species of *Lepidostoma*, in which it is very narrow.

The genus *Quisilo* Milne (genotype *Silo griseus* Hagen) and the subgenus *Aopsyche* Ross (genotype *Theliopsyche corona* Ross), are based primarily on secondary sexual characters of the male and I am doubtful if these represent significant phylogenetic divisions of the genus. Until additional material is available for study, it seems best to consider the genus *Theliopsyche* as an undivided unit.

KEY TO SPECIES

1. Maxillary palpi 3-segmented (males)....................................2
   Maxillary palpi 5-segmented (females)....................................5
2. Claspers elongate, with no dorsal lobe, but with a curved, sub-basal, finger-like lobe, fig. 37...**grisea**
   Claspers shorter, with a dorsal lobe (Ross 1938*a*: fig. 115)..................3
3. Ventro-mesal lobe of claspers long and truncate (Ross 1938*a*: fig. 115)...**epilone**
   Ventro-mesal lobe of claspers very short, either wide and truncate or hooked..4
4. Ventro-mesal lobe of claspers wide and truncate, front wing with very wide sub-costal cell, with branches of Radius crowded together (Ross 1938*a*: fig. 116)...**corona**
   Ventro-mesal lobe of claspers narrower, pointed and hooked (Ross 1944: fig. 885); venation without displacement of veins (Betten 1934: pl. 63, fig. 3), **parva**
5. Spermatheca moderately short, fig. 36................................**corona**
   Spermatheca very long, its free end lengthened into a long, subparallel tongue, fig. 35..**epilone**

Theliopsyche parva Banks

1911. *Theliopsyche parva* Banks, Am. Ent. Soc. Trans. 37: 356. ♂, ♀.

The species was described from Woodworth's Lake, Fulton County, New York, and no additional records are available. The species is readily distinguished by the ventral aspect of the claspers and the small mesal process of the eighth sternite. In 1937 I cleared the genitalia of the type and drawings made from this preparation have been published previously (Ross: 1944, fig. 885).

Theliopsyche corona Ross

1938. *Theliopsyche corona* Ross, Ill. Nat. Hist. Surv. Bull. 21: 174. ♂.

Originally described from Gatlinburg, Tennessee, the species has since been taken from Andrews Bald, Great Smoky Mountain National Park, North Carolina. This latter collection contains associated males and females.

The wings and maxillary palpi of the male illustrated in the original description are very striking, but the genitalia indicate a very close kinship with *parva*. In the female the wings are of the unmodified type and the spermatheca, fig. 36, is trianguloid and the elliptic ridge is wide, long and appears to project beyond the posterior margin of the spermatheca. The subgenital plate has two pairs of membranous horn-like processes, a mesal pair and a lateral pair.

Theliopsyche epilone Ross

1938. *Theliopsyche epilone* Ross, Ill. Nat. Hist. Surv. Bull. 21: 173. ♂.

The species was described from Newfound Gap, Great Smoky Mountains, North Carolina. Since then I have received a collection of associated males and females from the Smoky Mountains but on the Tennessee side. The female is identical in color and general structure with that of *corona*, differing chiefly in the elongate and tapered spermatheca, fig. 35.

Theliopsyche grisea (Hagen)

1861. *Silo griseus* Hagen, Syn. Neur. N. A.: 273. ♂.

Of this species I have seen only the unique male type from Trenton Falls, New Jersey. It is characterized by the very large mesal flap of the eighth sternite and the long clasper of the male, fig. 37. These illustrations are drawn from the preparation of the type. My notes are not complete on the structure of the tenth tergite and aedeagus but it is hoped that the details of the claspers will be of assistance in identifying the species.

GENERA NOT STUDIED

Genus *Atomyoides* Ulmer.—This genus was erected by Ulmer (1911: p. 25, figs. 10–13) for the species *bispinosa* Ulmer from Costa Rica. I have not had an opportunity to study this species. The genitalia are figured in detail by Ulmer and it is entirely different from any species recorded north of that area. It may eventually prove to belong to the genus *Lepidostoma* but the species does not fit well into any of the groups outlined for *Lepidostoma* in this paper and it seems better to consider the genus separate, at least for the time being. No female has been described for the species. I have not included this genus in the key because of lack of information regarding its structure. Betten (1934) suggests that it is a close relative of species which I am placing in the *Unicolor* group.

Genus *Eremopsyche* Banks.—At the present time I am unable to add to the information contained in the original description of this genus, which was erected by Banks (1901: p. 367, figs. 13, 14) for the Mexican species *frontalis* Banks. Banks' illustrations indicate that the genus is a close relative of *Lepidostoma*, and it is entirely possible that *frontalis* may be a close relative of some of the species at present placed in *Lepidostoma*.

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Ulmer, Georg. 1911. Einige Südamerikanische Trichopteren. Ann. Soc. Ent. Belg., 55: 15–26, 13 figs.

[1]For purposes of continuity, the letter designations are the same as those listed in Ross 1944.

LOS ANOFELINOS DE LA REPUBLICA DEL ECUADOR, by ROBERTO LEVI CASTILLO. 172 pages + 10 folded plates + 30 pages of photographs. Artes Graficas Senefelder C. A. Ltda., Guayaguil, Ecuador, 1945.

Morphological descriptions are given of all available stages of ten species of anophelines, one of which, ***pseudopunctipennis*** Theobald, is represented by two varieties, ***levicastilloi*** Levi Castillo 1944, and ***rivadeneirai*** Levi Castillo 1945. There is much information on ecology, geographic distribution, and significance in malaria transmission. Keys have been devised to separate eggs, larvae, females, and male terminalia. The ten folded plates are printed on both sides; fifteen are on anatomy and five on geographic distribution. Numerous photographs show mainly the breeding places of larvae and methods of collecting. There is a bibliography of over one hundred references and an index. The binding is paper and this volume is the first of a proposed series.—CARL E. VENARD.

ON SOME DIPLOPODS FROM THE INDO-AUSTRALIAN ARCHIPELAGO, by RALPH V. CHAMBERLIN. American Museum Novitates, Number 1282, 43 pages, 136 figures. 1945.

This publication is not revisional in nature but is made up of descriptions of new genera and species with a few notes on others already established and a key to the species of one genus, *Papuosoma.* Since sixty-four new species and fourteen new genera are described, it will be important to specialists in the group. The figures of anatomical details are well drawn and well printed.—A. W. L.

THE FEMALE GENITALIA OF THE WYEOMYIA OF NORTH AMERICA
(Diptera: Culicidae)

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Ohio State University

The difficulty in separating the females of our three species of *Wyeomyia* is well known to taxonomists who have studied this genus. Matheson (1944) points out the fact that the female of *W. vanduzeei* Dyar and Knab is very similar to *W. smithii* (Coquillett) the only diagnostic difference being the presence of white scales on the bases of the segments of the hind tarsi of *vanduzeei*. Matheson further states that the adults of *W. mitchellii* (Theobald) and *W. vanduzeei* are practically identical and that these two species can be distinguished with certainty only in the larval stage and by male genitalia. The larval and male genitalia characters are diagnostic for all three species of *Wyeomyia*.

There has been some controversy as to the value of female genitalia in the taxonomy of mosquitoes. Gerry (1932) in his review of the literature, finds fault with the methods of those workers who did not find specific characters of value because they " . . . failed to distend the abdomen sufficiently to separate the individual characters." After a study of nineteen species of Cuban mosquitoes, representing eight different genera, Gerry concluded that each generic group possesses diagnostic characters which can be used in the formation of a generic classification, and "In addition several promising specific characters have been observed, some of which are not manifest but may be made visible with the aid of a microscope." Gjullin (1937) studying the female genitalia of *Aedes* of the Pacific coast found that morphological characters are present which may be used to separate some of the species. However, the species having similar or identical coloration also have nearly identical genitalia and therefore he concludes that female genitalia in this group have only limited taxonomic value.

The present paper will show that our three species of *Wyeomyia* can be separated by female genitalia characters. The terminology (figs. 3–5) used in the present description is that of Edwards (1941) which in large part is based on the earlier works of Macfie and Ingram (1922), Christophers (1923), Gerry (1932) and Gjullin (1937). Specimens were cleared in KOH and mounted in chloral gum medium. Some of the adults studied were reared from known larvae. Locality data for the specimens examined are as follows: *W. smithii*—North Carolina (Wilmington), *W. vanduzeei*—Florida (Avon Park and Boca Raton), *W. mitchellii*—Florida (Avon Park, Boca Raton, and New Smyrna). The drawings were made with the aid of an ocular grid. Slides of the genitalia have been deposited in the Ohio State University Museum. The writer wishes to thank Roy W. Chamberlain for his aid with some of the drawings, and Dr. Carl E. Venard for critically reading the manuscript.

In the genus *Wyeomyia* (figs. 1–5), the cerci are reduced in length, somewhat compressed and truncate or nearly so apically. The postgenital plate is about the same length or longer than the cerci, truncate or rounded apically and basally appears narrow due to a concentration of pigment. These pigmented areas are best seen when the individual structures are dissected and mounted separately thus eliminating the interference of underlying parts which are plainly seen in a cleared specimen. Actually the lateral margins of the postgenital plate expand basally and fuse with the cowl and membranous anal segment. The postgenital plate comprises two portions, the proximal part, probably representing the tenth sternite and the distal part the eleventh sternite or postgenital plate proper. The cowl is well pigmented, band-like and separated from the postgenital plate by a membrane. Edwards restricts the cowl to the sclerotized posterior rim of the atrium whereas Macfie and Ingram speak of the sigma and cowl together as the ninth sternite and Gerry and Gjullin call the cowl the ninth sternite. The cowl bends anterodorsally and fuses with the sigma which doubles back posteroventrally. The insula is a small chitinous plate which lies in the midventral line closely associated with the sigma. In some genera this plate may be distinctly separated from the sigma by a membrane, or it may be fused to the sigma though still distinguishable from it by a difference in the pigmentation of the two structures. Christophers pointed out the fact that the "insula may be blended with the sigma." In the genus *Wyeomyia* the apron-like medial expansion of the sigma apparently represents the insula plate which has become so completely fused with the sigma that no line of demarkation between the two structures is visible. Insula setae are present. Edwards believes that the insula plate represents the vestigial ninth sternite. Atrial plates are absent. The ninth tergite is spicular and band-like with or without large setae. When present these setae vary frequently in number and arrangement. The tenth tergites are spicular, may or may not be wrinkled, and have indefinite outlines (in figures 4 and 5 the tenth tergites have been drawn more darkly outlined than they normally are). The tenth tergites articulate with the cerci and ninth tergite by means of a thin connecting membrane. Three round darkly pigmented spermathecae each with a small nipple-like projection are present. These sclerotized projections are the beginning of the spermathecal ducts.

KEY TO THE FEMALE GENITALIA OF WYEOMYIA

1. Postgenital plate distinctly rounded apically; insula plate broad, the sides almost parallel with rounded corners and a straight or slightly indented anterior margin (fig. 1) .... **smithii**

   Postgenital plate more or less truncate apically with slightly rounded corners; sides of insula plate parallel or gradually tapering to a rounded or indented anterior margin 2

2. Basal region of the postgenital plate with numerous round pores most of which bear minute setae; postgenital plate longer than cerci; anterior edge of insula plate round, not indented, with lateral and anterior margins pigmented, and with a round more lightly pigmented or colorless central area (fig. 3) .... **mitchellii**

   Basal region of the postgenital plate without round pores but with long slender setae extending up the entire ventral surface; anterior margin of the insula plate slightly or distinctly concave; lateral regions darkly pigmented and separated by a light medial strip (fig. 2) .... **vanduzeei**

Description of the Female Genitalia

Wyeomyia (Phyllozomyia) smithii (Coquillett)

(Figure 1)

Cerci—Short, roughly quadrangular, the corners rounded, anterior margin only slightly or not at all convex; inner and outer surfaces spicular with large setae restricted to about the apical half. *Postgenital Plate*—About as long as or longer than the cerci; apex rounded, both dorsal and ventral surfaces densely spicular; ventrally, large setae restricted to the apical half and a few setae irregularly dispersed below the middle; basally the pigment pattern forms a rounded area in which are found a dense grouping of minute spicules and rarely an occasional round pore from which may arise a fine seta; dorsal surface with numerous stout apical and subapical setae irregularly arranged and an occasional seta occurring below the middle of the plate. *Cowl*—A sclerotized band with slightly wavy margins and separated from the postgenital plate by a very light membrane; spicular, the spicules dense on the medial region, decreasing in number laterally so that the band at the point of junction with the sigma is almost completely bare. *Sigma and Insula Plate*—Sigma a lightly pigmented spicular membrane with a roundly indented posterior margin, extending ventrally to broaden into the apron-like insula plate; plate roughly quadrangular, its lateral margins parallel or indented posteriorly (near the anterior margin of the sigma); corners rounded, the anterior medial margin little or not at all indented; anterolateral corners of the plate more darkly pigmented and separated by a lightly pigmented region; plate covered with minute spicules and with a group of about seven to ten long slender setae arising from each darkly pigmented corner. *Ninth Tergite*—A broad finely spicular band whose anterior margin is nearly straight and posterior margin medially indented; with or without long setae; when setae are present their number and arrangement may vary as follows: one on

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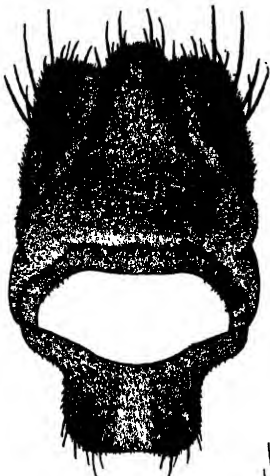
EXPLANATION OF PLATE I

Fig. 1. Ventral view of *W. smithii*. Fig. 2. Ventral view of *W. vanduzeei* (Tenth tergite lies dorsally behind the cerci and is not shown in the drawing). Fig. 3. Ventral view of *W. mitchellii*. Fig. 4. Lateral view of *W. mitchellii*. Fig. 5. Dorsal view of *W. mitchellii*.

ABBREVIATIONS

A—atrium	N—ninth tergite
AS—anal segment	P—postgenital plate
C—cowl	S—sigma
CS—cercus	T—tenth tergite
I—insula	

(In figures 1–3 the sigma has been pulled down so that the atrial cavity is shown much larger than normal; actually the cowl and sigma are folded together leaving a comparatively small opening to the chamber. Figure 4 shows the sigma partly folded towards the cowl. When the eighth segment is not dissected away and the genitalia is not under pressure of a cover glass, the sigma lies somewhat closer to the cowl and the insula points more posteriorly than that shown in figure 4. In figures 1 and 3 the cowl is also extended, exposing part of the membrane which joins it to the postgenital plate. Figure 2 shows the cowl in a more normal position.)



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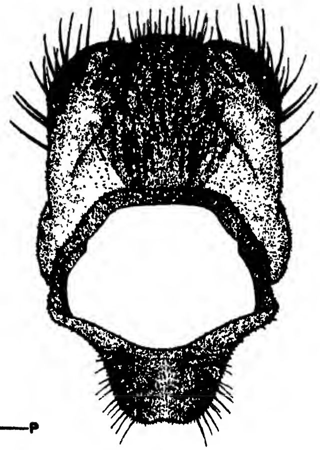

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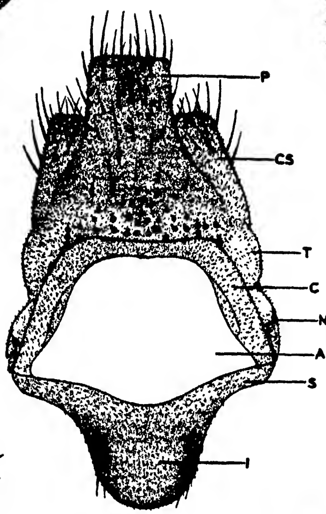

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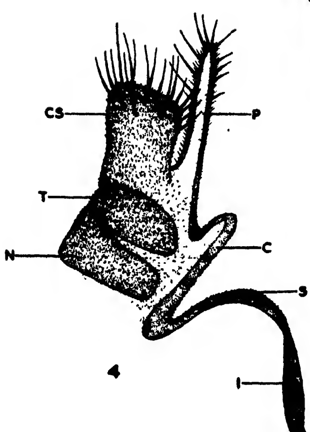

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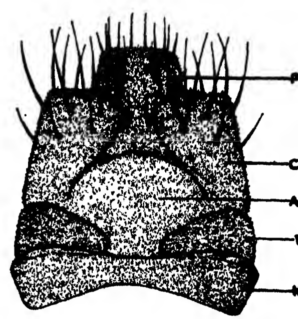

5

each side of the posterior median margin or two on one side and one on the other, or two on one side and none on the other. *Tenth Tergite*—Large, the margins somewhat irregular and weakly defined; wrinkled and covered with fine spicules (finer than those on the cerci) arranged in definite groups, the spicular pattern different from that on the cerci.

Wyeomyia (Phyllozomyia) vanduzeei Dyar and Knab[1]

(Figure 2)

Cerci—Short, almost truncate with rounded apical corners; distal half expanded and broader than the basal region; all surfaces spicular except for a small basal region on the inner surface; large setae restricted to the apical half of the outer and inner surfaces and an occasional seta occurring on the basal half. *Postgenital Plate*—About as long as or a little longer than the cerci, apex somewhat truncate or only a little rounded; ventral basal half (tenth sternite) rounded off by a dense grouping of fine spicules; long slender hair-like setae more or less regularly arranged within this finely spicular and more darkly pigmented area, and extending up the entire surface of the plate; dorsal subapical and apical surface with about twelve short stout setae; both surfaces of the plate spicular. *Cowl*—A spicular sclerotic band with the spicules extending laterally to the junction with the sigma. *Sigma and Insula Plate*—Sigma a narrow, lightly pigmented spicular band with an indented posterior margin and which extends ventrally and broadens into the median insula plate; sides of insula taper toward the middle to form a rounded, slightly or distinctly concave anterior margin; outer regions of plate darkly pigmented the two halves separated by a more lightly pigmented medial strip; entire plate spicular the medial spicules smaller than the outer ones; a group of about eleven or more long slender setae originate within the pigmented outer areas. *Ninth Tergite*—A fairly broad lightly pigmented spicular band whose anterior margin is deeply concave medially and posterior margin is almost straight; a variable number of large setae may occur on the posterior margin in the following combinations: a single seta on either side laterad of the middle; one or two large setae on one side only; or with three setae on one side and two on the other; or with three setae arranged medially all about equidistant, with one of the setae larger than the other two. *Tenth Tergite*—Small, roughly triangular, lightly pigmented and indefinitely outlined; not wrinkled, but with a spicular pattern slightly different from that on the cerci.

Wyeomyia (Wyeomyia) mitchellii (Theobald)

(Figures 3–5)

Cerci—Short, truncate with rounded apical corners; apical half

[1]The genitalia of this species has been described by Gerry (1932). However his description (and diagram) differ somewhat from the present one and seems to fit the characters of *mitchellii* (particularly the postgenital plate) more readily than *vanduzeei*. It is possible that the Cuban *vanduzeei* differs from our own or Gerry has actually described *mitchellii* as *vanduzeei*. Unfortunately Gerry does not give a detailed description of the basal half of the postgenital plate; had he done so there would be no question as to the species he has described. Both species are found in Cuba (Dyar, 1928).

broader than basal region; outer surface completely spicular, inner surface spicular only on apical half; large setae of various lengths restricted to the apical half of inner and outer surfaces. *Postgenital Plate*—About one third longer than the cerci; apex truncate with slightly rounded corners; basal region with a V-formed area marked off by slightly darker pigmentation (sometimes difficult to see); some slender setae found distributed over the ventral surface, but more numerous on the apical half (eleventh sternite); basal region of the plate (tenth sternite) with many large round pores from most of which may arise small setae; the pores extend below and laterally on either side of the V-shaped area (these structures appear very much like sense organs which have been described in the literature in other insects); stout apical and subapical setae are found on the dorsal surface; both surfaces of the plate spicular. *Cowl*—A sclerotized spicular band slightly concave on the posterior medial margin; spicules sparse near the junction with the sigma. *Sigma and Insula Plate*—Sigma a narrow spicular band which broadens anteriorly into the insula plate whose lateral margins may be more or less parallel or taper to a round convex anterior margin; lateral and anterior margins of plate more deeply pigmented than the central concave area; groups of nine to twelve setae are found within the darkly pigmented outer marginal regions; entire surface spicular, the spicules within the central lighter area smaller than the others. *Ninth Tergite*—A sclerotic band covered with minute spicules; posterior margin straight or slightly concave, anterior margin deeply concave; no large setae were noted. *Tenth Tergite*—Lightly pigmented with indefinite margins, wrinkled, finely spicular (finer than those on the cerci) the pattern different from that on the cerci.

CONCLUSIONS

The female genitalia of our three species of *Wyeomyia* have distinct diagnostic characters which are sufficiently constant to be of taxonomic value. The cerci and postgenital plate of *W. smithii* are much darker than the same structures of *vanduzeei* and *mitchellii*. Particularly the shape and chaetotaxy of the postgenital and insula plates show decided differences. Other minor variations are present and these are described for each species.

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CONNECTIVE TISSUE PATTERN IN THE VENTRICULUS OF CERTAIN LUBBER GRASSHOPPERS
(Orthoptera, acridiidae)

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In the routine course of examining the tissues of the entire gut length of two selected grasshoppers the writer was impressed by the fact that the literature, especially generalized texts on insect anatomy and physiology, give practically no space to the important but somewhat obscure connective tissue of the midgut. Although loose connective tissue is sufficiently obvious in the large folds of pharynx, proventricular teeth, and of the fore-intestine, the author had to persuade himself by repeated examination of the midgut tissues of *Brachystola magna* (Gir.) and *Romalea microptera* (Beauv.) that connective tissue was definitely an essential constituent in the region here referred to. It became increasingly obvious that such tissue should be present both from genetic and adaptational considerations. Especially was the adaptional value evident when it was observed in a variety of preparations that the midgut is completely invested in loose connective tissue so reinforced as to constitute a probably firm "elastic" network covering the bases of epithelial masses and penetrating up between them. The unsupported epithelium soft and folded as it is in the midgut and its caeca, could scarcely be expected to endure the viscissitudes of the abrasive and stretching effects of a mass of such coarse vegetation as these insects ingest.

An examination of all available literature did in fact disclose some reference to a "peritoneum" and even to the more specific presence of loose connective tissue in the midgut of certain other grasshoppers and particularly in the case of the beetle *Dytiscus marginalis*, quoted by Snodgrass from Korschelt's two volume monograph. It is true that references are made to connective tissue, elsewhere than in grasshoppers by Schimmer (1909) in *gryllids*, Deegner (1910) in *Dystiscus circumcinctus Ahr.*, Rungius (1911) in *Dytiscus marginalis* and the very recent and somewhat detailed treatment by Wermel (1938) with

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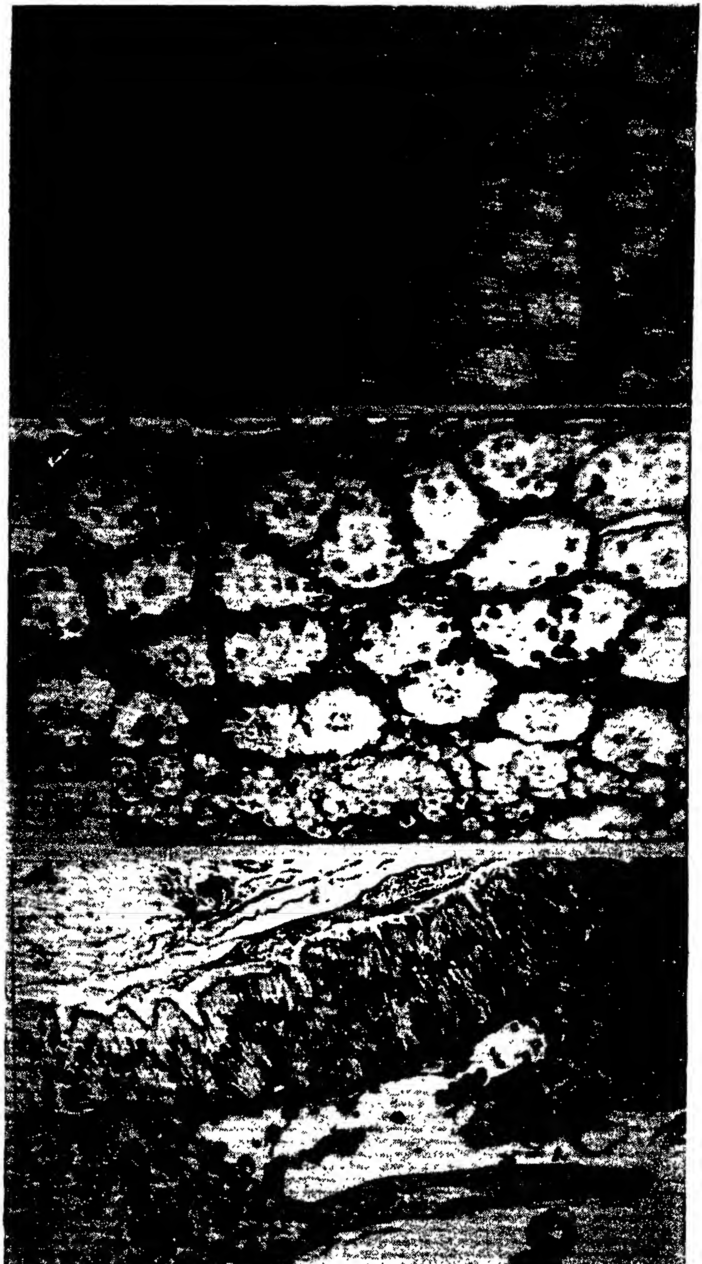
EXPLANATION OF PLATE I

FIG. 1. Superficial view showing relations of longitudinal muscles (broad, wide bands), finely placed parallel circular muscles, and faint irregular polygons of connective tissue network. The irregular dark area is a residuum of epithelial tissue not yet eroded away. Unretouched photo.

FIG. 2. Semi-tangential section, superficial or basal view of enteric epithelial units surrounded nearest the body cavity (top of cut) by connective tissue—as a "carpet" (extreme top) and as a network (lower top) and eventually tapering off and disappearing (lowermost, where individual slightly separated cells are shown.)

FIG. 3. Cross-section at true right angles to the gut axis at a point near the Malpighian ampules (attachment of Malpighian tubules to midgut-ilial juncture).



reference to a variety of connective tissues in several silkworms. The discussion of connective tissue in the midgut of certain grasshoppers is touched on by Tietz (1923) for the Carolina locust, by Woodruff (1932–1934) in certain other forms, in some detail, and by Hodges IV (1936) in *Melanoplus differentialis* and *Locusta migratoria*.

Wermel (1938) in his brief treatment of connective tissue in the body of the silkworm larvae makes the significant statement "das Bindegewebe der Insekten ist bisher wenig untersucht worden . . ." and further on he explains the scarcity of researches on this tissue in insects by reference to difficulties of observation and general neglect. All available descriptions and the few relevant figures still leave much to the imagination. It is therefore the writer's intention modestly to extend the information on the distribution and pattern of the loose connective tissue associated with the midgut wall, as seen in the two lubbers referred to. Only one grasshopper, *Brachystola,* is here figured in detail, the other being represented by fig. 1 only. However, the same facts in general apply to both species.

METHODS USED

In connection with the more inclusive study of the internal anatomy of these grasshoppers, many hundreds of specimens, fresh or Bouin's

EXPLANATION OF PLATE II

FIG. 4. Semi-tangential section cut through the midgut in the general direction of the line XX' of the next figure. In fact the line of cutting would be less steep. This line determines a plane at right angles to the paper of the Fig. (5). Approximate scale is indicated. A composite sketch. Compare with photo in Fig. 2.

FIG. 5. Generalized cross-sectional view of the midgut. Note that the connective tissue is prominent at the bounding and basal recesses between enteric epithelial units, and here the connective tissue thins out elbow said units and again tapers off as it rises between the units. In this way it is shown in sketch at left that the connective tissue forms cups about the base of epithelial masses. These are further crowded to form an open honeycomb structure, appearing in basal section as a network or reticulum.

ABBREVIATIONS USED

B—Basal connective tissue (between basement membrane of epithelial units and surrounding musculature).
BB—Brush border (cilial fringe of authors) of intima of epithelial cells.
CM—Circular muscles.
CTN—Nucleus of connective tissue cells.
CTR—Reticulum or net formed of connective tissue.
Cr—Crypt or infolding of the epithelial intima facing the lumen of the midgut.
ECT—Connective tissue ("peritoneum") enveloping muscles of the outer gut surface.
ECTN—Nucleus of a cell of the foregoing.
Ent. Ep. B.—Border or basement membrane of the cells of the epithelial units.
Ent. Ep. U.—Enteric epithelial mass or unit—part of "villus" of authors.
LM—Longitudinal muscles overlying circular muscles of gut.
MT—Malpighian tubules.
Nd—Nidus or compact cluster of new cells, basal in enteric units.
PM—Peritrophic membrane adjacent to brush border of epithelium in gut lumen.
Swls—Sidewalls, or projections from basally placed connective tissue, wedged between enteric epithelial units.
Tr—Tracheae and tracheoles in periventricular sinus and within connective tissue of gut.


LM
Nd
Cr
Ext. Ep.
BB
Cr
V
SMLs

injected, alcohol preserved, were used. Of these about two hundred were examined with reference to the present study.

Specimens of the ventriculo-intestinal region in case of the superficial examination pictured in fig. 1 were eroded in dilute sodium hydroxide, followed by gentle abrasion. For better contrast a bulk stain was applied after the necessary rinsing in alcohol and water. For detailed microscopic examination and photography, whole specimens were bulk-stained in Delafield's Hematoxylin, or stained, after mounting, in one of several triple stains for connective tissue. The best thickness for details lay in the region of 7 to 10 microns. The loose connective tissue appears as a continuous, somewhat stranded web or as an obscurely fibrous mesh depending on the fixation. It was rather sparsely nucleated, with nuclei of apparent disc shape, somewhat smaller than those of the epithelium, and with less chromatin substance. Individual cells when isolated were slenderly spindleform or irregular. Sections were available at any number of angles and one of particular interest was a wide tangential band observable in a horizontal section of the whole grasshopper abdomen, walls and all.

OBSERVATIONS

The triple stain as usual differentiated between muscle and loose connective tissue ground mass. The epithelium was also readily distinguishable either in its newest densest portion by a compact rich cytoplasm, by distinguishable cell boundaries or by an orange staining of less dense cytoplasm of the more developed cells.

The drawings, along with supporting photographs, will speak more clearly than words of the general relationships. It will be noticed that the general plan or pattern is as follows:

The epithelium is hardly composed of villi but rather of roughly polygonal clusters of elongated cells around an intimal depression or crypt. This, for the lack of an official designation, I am calling the enteric epithelial unit. This unit is set down, basally, into a cup-like container, one of many such, as in the foundation wax of a new honeycomb, and upon a general carpet-like sheet lying over the outer surface of the epithelium and between the epithelium and their enveloping enteric cylinder of finely placed circular muscles. Finally, outside these and closely invested in additional loose connective tissue, are the wider band-like longitudinal muscles. Sections often show these last-named muscles as quite separate from the gut wall, and in such cases their connective tissue wrapping is made more obvious.

The exact cellular detail and histological classification of the species of connective tissue encountered is not made an issue in the present report but rather the general appearance and the peculiar distribution. A later report is planned to more rigorously display the finer structure. This had already been suggested at least for certain grasshoppers other than the giant lubbers by the writers previously referred to. Wermel's suggestions point to other observations that should be made as to the exact character of connective tissue as applied to certain regions and to certain insects.

The most noticeable region of connective tissue is seen in sections, in the triangular recesses at the bases of the epithelial units. At such places one sees loose connective tissue ground mass, some nuclei of the sort described, and often sections of the small tracheae which typically penetrate connective tissue elsewhere in the gut and elsewhere in the body cavity.

The appropriateness of the term Connective Tissue, Reticulum or Net is seen in the eroded and teased specimen, and in more or less tangential sections. A term meaning "resembling honeycomb foundation" if such there were, would be more appropriate as it considers the third dimension. The wedge-like connective tissue "risers" or inter-epithelial wedges extend up between the units somewhat indefinitely, but probably about half the distance from outer gut wall to inner brush border. Semi-tangential sections show a little way from the outer gut wall very distinct between the epithelial units; in densely stained material, as solid walls with occasional compressed nuclei. These nuclei are not to be confused with those of the epithelial cells with their larger nuclei, plump in all directions, and larger, richer in chromatin granules. Nor is there any suspicion of the smaller, flattened connective tissue nuclei being misplaced nuclei of the epithelium. In epithelium more remote from the gut wall and nearer the gut lumen the connective tissue disappears from view and is finally replaced by non-nucleated cell apices quite loosely aggregated.

It is presumed that further study will show the described connective tissue distribution and pattern to be common at least to the Acridians and since it has been referred at least to a beetle, several silkworms and Cybister, it is reasonable to presume its more general occurrence in insects as a gut element, if not in general peritoneum.

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THE ENTOMOLOGICAL SOCIETY OF AMERICA

PROCEEDINGS OF THE FORTIETH ANNUAL MEETING

St. Louis, Mo., March 27, 28 and 29, 1946

The Entomological Society of America held its fortieth annual meeting on Wednesday, Thursday, and Friday, March 27–29, 1946, in conjunction with the annual meeting of the AAAS, with Headquarters in the New Hotel Jefferson, where the meetings were held. The North Central States Branch of the American Association of Economic Entomologists met at the same time and the two groups covered one joint session and sponsored the Entomologists' Banquet.

The attendance of the two entomological groups was about 200. Many others would undoubtedly have come to the meetings except for inability to obtain reservations.

The program presented at the three-day meeting follows:

Wednesday Morning, March 27, 10 A. M.

President Rehn called the session to order and announced the appointment of the following committees:

Nominating Committee—C. E. Mickel, Chairman; R. H. Beamer, Curtis Sabrosky.

Resolutions Committee—H. B. Hungerford, Chairman; J. C. Bradley, E. Gorton Linsley.

The following papers were presented:

1. The Salticidae of Panama (spiders) (by title). A. CHICKERING, Albion, Michigan.
2. The Comparative Anatomy of the Internal Genitalia of some *Tischeria* (Lepidoptera) (by title). J. L. WILLIAMS, Lincoln University, Pennsylvania.
3. The Present Status of the Insect Collections in Europe, (15 min.). MAJOR JOHN W. BAILEY, U. S. Army.
4. The Condition of Some of the Italian and German Insect Collections, (15 min.). B. D. BURKS, Illinois Natural History Survey.
5. Entomology in Japan, (15 min.). J. LINSLEY GRESSITT, St. Louis, Missouri.

Wednesday Afternoon, March 27, 1:30 P. M.

Presentation of Papers, continued:

1. What is an Insect? (15 min., lantern). J. CHESTER BRADLEY, Cornell University.
2. Identification of Female Anophelines of the United States, (15 min., lantern). R. L. USINGER, U. S. P. H. S.
3. Taxonomic Studies in Corixidae, (15 min., lantern). H. B. HUNGERFORD, University of Kansas.
4. An Undescribed Eversible Gland in the Larva of *Chlaenius* (Coleoptera, Carabidae), (10 min., lantern). W. P. HAYES, University of Illinois, and and H. F. CHU, Urbana, Illinois.
5. The Number of Gastric Caeca in Some Larval Scarabaeoidea (7 min., lantern) (by title). Z. P. METCALF, University of North Carolina.

6. The Transmission of ***Litomosoides carini***, Filarid Parasite of the Cotton Rat, by the Tropical Rat Mite, ***Liponyssus bacoti***, (15 min., lantern). ROGER W. WILLIAMS and HAROLD W. BROWN, U. S. Navy.
7. An Analysis of the Temperature Coefficients of DDT Action, (15 min., lantern). HSING-YAN Fan, University of Minnesota.
8. Biology of Dermestidae (15 min.). E. GORTON LINSLEY, University of California.
9. The Breaking of Diapause in Eggs of the Forest Tent Caterpillar, (15 min., lantern). A. C. HODSON, University of California.
10. The Metamorphosis of the Cephalic Ganglia of the Mosquito, (15 min.). WILLIAM ROGOFF, East Haven, Connecticut.
11. The Development of ***Tribolium confusum*** Duv. on Edible Soy Products, (15 min., lantern). C. E. MICKEL, University of Minnesota.

Thursday Morning, March 28, 10 A. M.

JOINT SESSION WITH NORTH CENTRAL STATES BRANCH

The joint session of the Entomological Society of America and the North Central States Branch was opened by J. J. Davis, President, North Central States Branch, in the chair, and the following program was presented:

1. Greetings from the National Societies and Remarks by CLAY LYLE, President of the American Association of Economic Entomologists and JAMES A. G. REHN, President of the Entomological Society of America.
2. The History, Organization, and Activities of the Insect Control Committee of of the Office of Scientific Research and Development, CLYDE KEARNS, University of Illinois.
3. The Outlook of Entomology in the National Science Foundation. Discussion from the floor.
4. Summary of Insect Conditions for 1945 and the Outlook for 1946, P. N. ANNAND, Bureau of Entomology and Plant Quarantine.

Appointment of committees.

Thursday Afternoon, March 28, 1:30 P. M.

The Entomological Society continued the program of presentation of papers, Vice-President E. Gorton Linsley in the chair.

1. Some Preliminary Determinations of Histamine and Related Substances in Insect Tissues, (15 min.). LAURENCE K. CUTKOMP, University of Minnesota.
2. A Modified Interpretation of the Chemical Organization of the Cuticle of Insects, (15 min.). A. GLENN RICHARDS, University of Minnesota.
3. Stability in Family Names; Some Principles and Problems, (15 min.). CURTIS W. SABROSKY, U. S. P. H. S.
4. Nearctic ***Stenus*** of the ***Croceatus*** Group (Coleoptera, Staphylinidae), (10 min., lantern). M. W. SANDERSON, Illinois Natural History Survey.
5. Ectoparasites of the Common Rat, (15 min., lantern). R. W. STRANDTMANN, University of Texas.
6. Distribution and Host Relationships of the Polyctenidae (10 min., lantern). ROBERT L. USINGER, U. S. P. H. S.
7. ***Trombicula deliensis*** and its Relation to Scrub Typhus in Assam, India, (15 min.). CAPT. ROBERT TRAUB, Typhus Commission.

Chairman Linsley adjourned the presentation of papers and turned the meeting over to President Rehn for the annual business meeting, which is reported here at the end of the presentation program.

Thursday Evening, March 28, 7 P. M.

The entomologists' banquet was held in the Crystal Room, with J. J. Davis as Toastmaster.

After the banquet, President Rehn gave the Presidential Address of the Entomological Society, "Entomology as an Integrant Part of Zoological Science."

Friday Morning, March 29, 9:30 A. M.

The Entomological Society held a joint program with the Ecological Society of America, Mary Talbot, Chairman. The following papers were presented:

1. Temperature Tolerations of Aquatic Insects in Mexico, (10 min.). H. D. THOMAS, North Park College, Chicago, Illinois.
2. Population Movement and Length of Life in *Colias* Adults (Alfalfa Butterfly), (10 min.). W. HOVANITZ, University of Michigan.
3. Camouflage and the Infra Red, (10 min.). LORUS J. MILNE, University of Pennsylvania.
4. Population and Control Studies of the Palau Gnat on Peleliu, Western Caroline Islands, (15 min.). C. K. DORSEY, Webster Groves, Missouri.
5. Biotic Barriers to Termite Distribution, (15 min., lantern). ALFRED E. EMERSON, University of Chicago.
6. Differential Feeding in Relation to Local Distribution of Grasshoppers, (10 min., lantern). F. B. ISELY, Trinity University.
7. Predaceous Conocephalinae, (5 min.). F. B. ISELY, Trinity University.
8. Comparative Toxicity of p-Halogen Analogs of DDT to Fish and Mosquito Larvae, (10 min., lantern). EUGENE P. ODUM and W. T. SUMERFORD, University of Georgia.
9. The Application of Average Minimum Daily Temperatures to Redefine Merriam's Life Zones in Eastern North America, (15 min., lantern). J. CHESTER BRADLEY, Cornell University.
10. Effects of Parasite Population Density on Populations of Host and Parasite, (10 min., lantern), PAUL DE BACH and H. S. SMITH, University of California Citrus Experiment Station, Riverside, California.

Exhibits

Two exhibits were shown by members of the Society, as follows:

1. Mosquito Portraits, ROBERT L. USINGER, U. S. Public Health Service.
2. Japanese Entomological Publications, CHARLES L. REMINGTON and J. LINSLEY GRESSITT.

Thursday Afternoon, March 28, 3:15 P. M.

President Rehn called to order the annual business meeting of the Entomological Society of America.

REPORT OF THE SECRETARY

Executive Committee Activities During the Year 1945:

Twenty-five members were elected to membership by mail ballot. A Committee on Biographies was appointed by President Rehn to collect obituaries and other biographical data for the Society. During the year DR. C. H. KENNEDY resigned as Managing Editor of the "Annals," and DR. A. W. LINDSEY was appointed to fill the post. These and other items of business, up to November 1, 1945, have been published in the Annals.

On December 5 PRESIDENT REHN appointed DR. R. L. WEBSTER of the Agricultural Experiment Station at Pullman, Washington, as the Society's representative of the inauguration of DR. WILSON MARTINDALE COMPTON as President of the State College of Washington, at Pullman, Washington, on December 11.

PRESIDENT REHN appointed an Auditing Committee of H. O. DEAY, D. M. DELONG, B. T. HODGES, and R. A. BLANCHARD, *Chairman*, and appointed PHIL RAU and C. K. DORSEY to a joint Local Arrangements Committee.

Annual Executive Committee Meeting:

The Executive Committee convened in Private Dining Room No. 5 at the New Hotel Jefferson at 8:00 P. M., March 27, 1946, with the following members present: JAMES A. G. REHN, E. GORTON LINSLEY, A. W. LINDSEY, HERBERT H. ROSS. PRESIDENT REHN designated the following alternates who were also present: H. B. HUNGERFORD, E. N. CORY, CLAY LYLE, ROBERT USINGER, J. CHESTER BRADLEY, and M. W. SANDERSON.

Twenty-eight persons were elected as members of the Society, listed in the Section of New Members. The following have resigned during the year: ANDRE AUDANT, EDWARD WILLIAM BAKER, MILTON D. FARRAR, CARL FILSINGER, BERTA B. KESSEL, HELEN C. MANK, MANLIO MANZELLI, RALPH B. MARCH, RAIFORD A. ROBERTS, P. E. SCHAEFER, GEORGE K. SCHUMAKER, IRVING SIEGEL, S. W. SIMMONS, HAROLD M. STEINER, RAYMOND L. TAYLOR, THOMAS COBB WATKINS, and WAYNE L. HOWE.

The following have been automatically dropped as members either because of failure for three or more years to pay dues, or because they cannot be reached: GEORGE W. BARBER, GALE GATES BLEASDELL, IVAN CHESSUM BROOKS, RALPH J. BUSHNELL, ROY W. CHAMBERLAIN, THEODOR R. GARDNER, JOHN D. HITCHCOCK, H. G. JOHNSTON, GUY F. MACLEOD, ARTHUR PORTER MCKINSTRY, DARRELL R. MADDOCK, ROBERT M. MELAMPY, SEATON C. MENDALL, F. W. MILLER, WILLIAM PITT MORGAN, JAMES HUBERT PEPPER, MANUEL M. PETRAKIS, RITCHARD READE, MYRON W. SMITH, and JOSEPH BENJAMIN TUCK.

The Executive Committee elected the following Fellows: CHARLES T. GREENE, F. B. ISELY, F. M. JONES, M. D. LEONARD. L .E. ROZEBOOM, CLYDE F. SMITH, C. WILLEMSE, and ELWOOD C. ZIMMERMAN.

The Society has suffered the loss by death of the following nine members: JOHN BARLOW, WILLIAM T. DAVIS, T. H. FRISON, U. C. LOFTIN, EDITH W. MANK, JOHN D. MAPLE, R. C. SHANNON, RALPH H. SMITH, and FRANK H. TAYLOR. Following the announcement of these losses to the Society, the members stood in silence in honor of the memory of those who have died in the last year.

It was moved and seconded that members having 35 years as a member in the Society and having attained the age of 65 be given the option of maintaining their membership without payment of dues and without receiving the Society's publications. Motion carried.

The following were elected to fill three vacancies on the Editorial Board: FRANK YEAGER, JOSEPH C. BEQUAERT, and WILLIAM PROCTER. These will serve through 1948.

The following were elected to fill the vacancies in the Thomas Say Foundation for a period of two years: HERBERT SCHWARZ and ROBERT USINGER for full terms, and H. H. ROSS to fill the unexpired term of T. H. FRISON.

It was moved and seconded to contribute $100.00 to the support of Zoological Record. It was moved and seconded that the President and Secretary be empowered to meet with the President and Secretary of the American Association of Economic Entomologists to decide the time and place of the next annual meeting. Motion carried.

It was moved and seconded that it was the opinion of this committee that the Executive Committee has full power to appoint the Managing Editor and that the Editorial Board has full power to handle all matters concerned with the Annals including the responsibility for the stock. Motion carried.

It was moved and seconded that a sum up to $50.00 be allotted to the expenses of the American Committee on Entomological Nomenclature for 1945 and 1946. Motion carried.

The Executive Committee adjourned at 12:00 midnight.

Respectfully submitted,

HERBERT H. ROSS, *Secretary.*

It was moved and seconded that the Secretary's Report be accepted. Motion carried.

TREASURER'S REPORT

December 1, 1944, to March 14, 1946

Current Fund

RECEIPTS

Balance on hand December 1, 1944	$3,787.74
Life Memberships	100.00
Annual Dues	5,052.80
Total	$8,940.54

EXPENDITURES

Stamps, Envelopes, Printing, and Clerical Help	$ 213.83
Cost of 1944 Meeting	97.10
Annals, from September, 1944, to December, 1945, and reprints	4,823.35
Traveling Expenses of Secretary-Treasurer	51.42
Traveling Expenses, E. O. Essig, National Research Council	53.64
Miscellaneous	30.80
Permanent Fund	250.00
Zoological Record; Zoological Society of London	100.05
Total	$5,620.14
Balance	3,320.40
	$8,940 54

Permanent Fund

RECEIPTS

Balance as of December 1, 1944	$4,327.40
Live Memberships (from Current Fund)	250.00
Interest on War Bond	2.16
Interest on Savings Account	16.67
Liberty Bond	50.00
Balance in Permanent Fund	$4,646.23

Total Resources of Society

Balance in Permanent Fund	$4,646.23
Balance in Current Fund	3,320.40
Total Balance	$7,966.63

REPORT OF THE MANAGING EDITOR

The transfer of the editorship from Columbus to Granville has necessarily caused some difficulty in re-establishing an orderly routine. Thanks to Mr. J. B. Gerberich, who has been willing to care for the reserve stock of the Annals in Columbus, and to Mrs. Helen S. Lanman, Dr. Kennedy's secretary for many years, it has been possible to handle the bulk of sales and the entire mailing list as before. Mrs. Lanman is, of course, thoroughly familiar with this work. She has been interested in it and has wanted to continue the work as long as we need her. I cannot overemphasize my debt to her and to Mr. Gerberich.

The addressograph plates have been maintained at the mailing room of the Ohio State University. I have been able to arrange for the continuation of their service through the willingness of Miss Doris Cripps, an addressograph operator

at the mailing room, to handle our work on her own time. The arrangement involves a small additional expense, averaging about five dollars per issue.

All of the reserve stock of the Annals but a small supply shelved at O. S. U. has been shipped to Granville for storage until a business manager is chosen. This material, boxed for shipment, amounted to about one and one-half loads for a large trailer truck. We have fireproof storage for it in the Life Science Building at Denison, hence it is safe. The inefficiency of the present arrangement, however, is a source of worry. Since the disposal is temporary I have opened packing cases at intervals to fill orders for reprints, with the result that an order for a few dollars worth of reprints may consume two or three hours of my time in shifting heavy cases and sometimes opening one for the withdrawal of a single small reprint. The establishment of a permanent managership will, of course, make it possible to systematize a complete stock of this material for convenient withdrawal of separate items. We are using one large storeroom and part of another for the stock in its present state. Much of it may remain in packing cases as a reserve, but a complete series of back numbers and reprints will require a considerable amount of shelving. Once a moderate stock is shelved orders can be filled quickly and efficiently.

The editing of the Annals has offered less problems, since I was already familiar with the established routine. Although Columbus is 27 miles from Granville, it is our chief shopping center, hence I am able to combine the necessary visits to printer and engraver with other errands. I owe an apology to our authors for tardiness in returning drawings and cuts during the first year of my editorship, but this delay has now been largely cared for and returns will be made from now on soon after the material is published.

In editorial policy I have carried on with no considerable change, awaiting an opportunity for a conference with the editorial board. The inclusion of "News of the Moment" from time to time has seemed to Dr. Ross and me a desirable innovation to acquaint members with the more important items of Society business. It requires little more space than a full annual report and adds timeliness in the presentation of occasional items.

Some of the minor irritations of publication are soon to be removed. The printers have been troubled by insufficient help, hence several issues have appeared very late. I hoped that the March issue might be in the mail before the meeting, but I doubt that they succeeded in getting it out, although it has been in page proof since the 16th. We are to return to heavier paper with this issue—a welcome step from all points of view.

For the future several problems face us. Most important is the selection of a business manager. I quite agree with Dr. Kennedy that the full duties of the managing editor have become too great for one man to carry as a labor of love—indeed, too great for one man to carry on any basis if he has a responsible position as a source of livelihood. This problem was referred to the Editorial Board by the Council last year, but no member of the Board has been able to offer a helpful suggestion. We profit by our connection with Spahr and Glenn, the printers, hence it would be desirable to retain the management of the Annals in or near Columbus. Unfortunately the faculty of Denison University is too small to offer any candidates and I understand that no one at Ohio State University is interested.

A second problem relating to the purely editorial work troubles me. Frankly I feel that the editor should be connected with a large institution which has a department of entomology so that he could work with an assistant who could take over in emergencies.

Lastly the practical problem of cost must be faced. We have been paying close to $6.00 per page for printing and mailing. On my last visit to the printers they broke the news gently that an increase is to be expected. Since the cost of engraving is borne by our authors we are not concerned with possible increases there as a matter of Society financing. We have published a 610-page volume in 1945 partly because of government restrictions on paper and partly because we have caught up with our large accumulation of manuscripts. We had money to publish a larger volume if material had been available, and can do so in 1946 if manuscripts continue to come in as they have in recent weeks. I anticipate that the current meeting will bring in enough articles to carry us through several issues.

In conclusion I wish to express my appreciation to the Society for the honor and privilege of carrying on the work of the Annals. Whether I continue it or not I shall always be glad for having been able to do it during the last difficult war year when Doctor Kennedy's health made it necessary for him to resign after his long and able service to the Society.

Financial statement of the Granville office from the time of transfer from Columbus to the end of January, 1946. The books were balanced to this date instead of the end of the year 1945 because a few items of income received in 1945 were not deposited until January.

RECEIPTS

Balance transferred from Columbus	$135.84
Cash on hand at time of transfer	23.52
Received from authors for cuts	147.62
Received from sale of reprints	5.55
Contribution from Dr. William Procter	500.00
Total	$812.53

DISBURSEMENTS

Engraving	$163.25
Postage	17.30
Stationery	36.23
Storing back numbers and reprints	32.70
Addressing wrappers	22.50
Bank charge	.25
Balance in bank January 31	540.50
Total	$812.53

FINANCIAL STATEMENT OF THE COLUMBUS OFFICE

Funds received to January 1, 1946	$1,382.95
Expenditures and bank charges to January 1, 1946	974.40
Bank balance, January 1, 1946	408.55
Total	$1,382.95

Respectfully submitted,

A. W. LINDSEY, *Managing Editor.*

REPORT OF THE EDITOR AND TREASURER OF THE THOMAS SAY FOUNDATION

The Thomas Say Foundation was organized to publish entomological monographs which are not acceptable by commercial publishers because of small sales. Until recently the Foundation attempted to publish volumes without a "foundation" of money, depending on the sale of volumes for publication funds. As a result, the publication of the first three volumes has depended on sales with little to encourage publication of further volumes. However, by the first of 1945 the Foundation had $571.32, with a good supply of the first three volumes. As reported in our report a year ago, $2,000.00 was provided by W. S. BLATCHLEY, increased by $99.42 during the past year. In addition, $1,000.00 has been provided by DR. HYMAN, president of Velsicol Corporation, so that we now have at last a Foundation totaling $3,734.32, as shown in the following financial report.

A valuable manuscript is available and ready to be published as soon as a suitable publisher will accept our manuscript. It is to be hoped this manuscript will be published during the present year.

The financial report follows:

RECEIPTS

Balance on hand, December 1, 1944	$2,571.32	
1945 sales of Volume I—2 @ $3.00	6.00	
1945 sales of Volume I—1 @ $2.65	2.65	
1945 sales of Volume II—2 @ $5.00	10.00	
1945 sales of Volume II—1 @ $4.50	4.50	
1945 sales of Volume III—1 @ $4.00	4.00	
Interest to December 31, 1945	38.18	
Received from W. S. Blatchley Trust	99.42	
Received from Dr. Hyman	1,000.00	
Total Receipts		$3,736.07

EXPENDITURES

Postage	$ 1.75
Balance in Purdue State Bank, March 1, 1946	$3,734.32

Respectfully submitted,

J. J. DAVIS, *Editor and Treasurer.*

REPORT OF THE AUDITING COMMITTEE

We, the undersigned, beg to report that we have examined the accounts of the Treasurer of the Entomological Society of America, the Editor and Retiring Editor of the Annals of the Society, and the Treasurer of the Thomas Say Foundation and have found them to be balanced and correct as of March 1, 1946.

The accounts of the Treasurer, H. H. Ross, were examined by R. A. BLANCHARD; those of the Editor, A. W. LINDSEY, and the retiring Editor, C. H. KENNEDY, by A. B. HODGES and D. M. DELONG; and those of the Treasurer of the Thomas Say Foundation by H. O. DEAY.

Respectfully submitted,

DWIGHT M. DELONG,
HOWARD O. DEAY,
R. A. BLANCHARD, *Chairman.*

It was moved and seconded that the reports of the Treasurer, Managing Editor, and Treasurer of the Thomas Say Foundation be adopted, together with the report of the Auditing Committee. Motion carried.

REPORT OF THE JOINT COMMITTEE ON COORDINATION OF ENTOMOLOGY WITH THE WAR EFFORT

To the President and Executive Committee of the American Association of Economic Entomology and of the Entomological Society of America, respectively:

Your committee has been inactive during the year insofar as formal meetings and modifications of the program heretofore reported are concerned.

The original charter of the committee charged it with the duty of directing the resources of the entomological profession into those channels where entomology should most effectively promote the over-all war effort of the nation.

Inasmuch as the activities associated with the placement of entomologists in the armed forces where their training and abilities could be most effectively utilized were very properly delegated to a special committee, the Coordination Committee had no direct part in that work. Your committee did, however, maintain the position that the members of the entomological profession as a group should not be given preferential treatment with respect to induction into the

armed services on the grounds that they were needed at home. This was because of a strong conviction, amply supported by subsequent events which are now history, that entomologists could be even more valuable in the armed forces than at home.

The committee dedicated the entomological profession to the pledge that those members who, for one reason or another, were not qualified for military service increase their efforts, both individually and cooperatively, to the end that national health be maintained and that losses from insect pests in food production be reduced to the lowest possible level.

The earliest and most important action of your committee was to inaugurate a comprehensive plan for cooperation among entomologists and with other agencies and industries. To this end a carefully chosen system of committees and subcommittees was set up. Entomologists from all over the country were given specific assignments which were carried out far beyond the expectations of the parent committee. Indeed, abilities and skills were discovered which previously were not known to exist.

From time to time, minor changes were made in the first formal organization of the committee's over-all plan but these were relatively few.

The last assembly of the committee was held December, 1944, in connection with the New York meetings of the American Association of Economic Entomologists and the Entomological Society of America. Because of the trend the war took early this year and because the existing program was operating smoothly, there seemed no justification to call the committee together in 1945. However, the 1944 personnel, together with A. Glenn Richards, who was appointed by President Rehn as an additional member of the committee, was willing to continue to serve when requested to do so by Presidents Van Dine and Rehn, and to stand by for any emergency that might arise.

In view of the significant service that entomology contributed in winning the war, your committee recommends that the officers and Executive Committees of the American Association of Economic Entomologists and of the Entomological Society of America give serious consideration to the advisability of assembling and publishing an historical record of the services rendered by entomology which were concerned directly with the war effort. This should include both the foreign and home fronts.

Finally, we commend entomologists for the part played by our profession in World War II. Especially do we salute those who served in the armed forces. We cannot help but be proud of the fact that among our number is found one of the most decorated men in the service.

Respectfully submitted,

D. L. Van Dine, *Ex-Officio*,
J. A. G. Rehn, *Ex-Officio*,
E. N. Cory,
L. M. Peairs,
S. A. Graham,
Avery S. Hoyt,
E. F. Phillips,
A. Glenn Richards,
P. D. Sanders,
J. S. Houser, *Chairman*.

On motion the report of the Joint Committee of Coordination of Entomology with the War Effort was accepted and the recommendations referred to the Executive Committee.

AMENDMENT TO CONSTITUTION

Pursuant to the notice of a proposed amendment to the Constitution adopted at the New York meetings, it was moved and seconded that the following sentence be added to Section 3, Article 4, of the Society's Constitution: "In the event that such a meeting is not held, the officers shall continue to function until the next annual meeting." Motion carried.

PROPOSED NEW PUBLICATION

Journal of Insect Physiology and Toxicology

This subject was introduced by Dr. Max Day with additional discussion by A. G. Richards, Jr., and H. H. Ross. After discussion from the floor, it was moved and seconded that the President be instructed to appoint a committee of three to investigate the problem, to contact the AAEE to ascertain its degree of interest and possible co-sponsorship, and after due consideration and suitable arrangements to proceed with steps necessary to initiate such action as may seem desirable and feasible. Motion carried. President Rehn then nominated Dr. Franklin Yeager, *Chairman*, Dr. Clyde Kearns and Dr. A. G. Richards, Jr., as a committee of three to put this motion into effect.

REPORT OF THE COMMITTEE ON RESOLUTIONS

1. Whereas, planning and arrangements for national scientific meetings under the present post-war conditions involve problems of the greatest difficulty,

Therefore be it Resolved, that we express our appreciation to the Joint Committee for Local Arrangements: J. A. Denning, *Chairman;* Phil Rau, J. C. Dawson, and C. K. Dorsey; to the Officers of the Society; and to the American Association for the Advancement of Science, for their efforts on behalf of this meeting.

2. Whereas, accommodations for the present meeting were most difficult to provide,

Therefore be it Resolved, that we express our gratitude to the management of the Jefferson Hotel for the use of their rooms and other facilities and to the St. Louis Housing Bureau for its efforts to make housing facilities available.

3. Whereas, there has been a tendency in recent years to overlook the role of Entomology in the general field of Zoology,

Therefore be it Resolved, that we express our appreciation to our President, James A. G. Rehn, for his willingness to address the Society on the important subject of "Entomology as an Integrant Part of Zoological Science."

4. Whereas, the accurate identification of insect and other arthopod vectors of disease is of utmost importance under both war and peacetime conditions,

Therefore be it Resolved, that the Society commend the U. S. Public Health Service for its film strip entitled "Identification of Female Anophelines of the United States" and similar educational taxonomic projects.

5. Whereas, during the past year our Society has suffered the loss of several of its members through death,

Therefore be it Resolved, that we express our appreciation for the services of these members through an expression of sympathy to be sent to a surviving relative of each deceased member.

6. Whereas, Dr. William Procter has once more generously contributed a sum of $500.00 to the Annals of the Entomological Society of America for the year 1945–1946,

Therefore be it Resolved, that the sincere appreciation of the Society be expressed to him for his generous confidence and support.

7. Whereas, Dr. Julius Hyman has generously contributed a sum of $1,000.00 to the Thomas Say Foundation,

Therefore be it Resolved, that the sincere appreciation of the Society be expressed to him for his generous support.

Respectfully submitted,

J. C. Bradley,
E. Gorton Linsley,
H. B. Hungerford, *Chairman*.

On motion the report of the Committee on Resolutions was accepted as read.

REPORT OF THE NOMINATING COMMITTEE

Your committee places for nomination the following Fellows of the Entomological Society of America to fill the designated offices for the year 1946:

President—C. F. W. MUESEBECK, Bureau of Entomology and Plant Quarantine, Washington, D. C.

First Vice-President—S. A. GRAHAM, University of Michigan, Ann Arbor, Michigan.

Second Vice-President—ALVAH PETERSON, Ohio State University, Columbus, Ohio.

Secretary-Treasurer—H. H. ROSS, Illinois Natural History Survey, Urbana, Illinois.

Executive Committee—
ROBERT MATHESON, Cornell University, Ithaca, New York.
R. L. USINGER, USPHS, Atlanta, Georgia.

Councilors to the American Association for the Advancement of Science—
STANLEY W. BROMLEY, Bartlett Tree Research Laboratories, Stamford, Conn.
ROGER B. FRIEND, Agricultural Experiment Station, New Haven, Conn.

Respectfully submitted,

R. H. BEAMER,
CURTIS SABROSKY,
CLARENCE E. MICKEL, *Chairman*.

On motion the report of the Nominating Committee was accepted and the Secretary was instructed to cast a unanimous ballot for the persons nominated. This being done, they were duly elected.

President Rehn introduced for discussion a report submitted by Dr. Robert H. Griggs regarding the educational situation in agriculture and forestry. President Rehn proposed that the incoming President study the matter and appoint a committee to approach the AAEE with the thought of obtaining similar data for the entomologists, and investigating the relation of the Entomological Society of America to the proposed National Research Foundation. After considerable discussion it was decided to place this matter before the incoming President for his action.

Following the transaction of the above business, the meeting adjourned.

NEW MEMBERS

ELECTED MARCH, 1946

H. BRUCE BOUDREAUX, Dept. of Zoology, Louisiana State University, Box 8729, Baton Rouge 13, Louisiana.
FRANK A. COWAN, 2201 Schulle St., Austin, Texas.
SAM MADISON COX, 127 North Tenth Ave. East, Duluth 5, Minnesota.
GEORGE H. EBERLEIN, West Concord, Massachusetts.
PEDRO GALINDO, Campana Anti-Malarica, Ministerio de Pr. Social, Panama, Republic of Panama.
ALBRO T. GAUL, 401 Washington Ave., Brooklyn 5, New York.
ALMA RUTLEDGE GOLDBERG, JR., 621 St. Johns Road, Baltimore 10, Maryland.
DONALD ROSS JOHNSON, 6409 Tahoma Ave., Chicago 30, Illinois.
JACK D. JONES, Box 212, R. R. No. 1, Fort Collins, Colorado.
WILLIAM W. JUDD, 297 Glen Road, Toronto, Ontario, Canada.
HARRY H. LAIDLOW, JR., F.S.C. Laboratory, 281 South St., Jamaica Plain 30, Massachusetts.
DALE R. LINDSAY, P. O. Box 932, Pharr, Texas.

CARL E. LUDWIG, 19 Gates St., Manchester, New Hampshire.
WILLIAM R. M. MASON, 11537 97th St., Edmonton, Alberta, Canada.
RALPH H. MILLER, 581 Euclid Ave., Apt. 5, Upland, California.
TOSHIO NAKAJIMA, Entomological Institute, Imperial University, Hokkaido, Sapporo, Japan.
W. E. RICKER, Indiana University, Bloomington, Indiana.
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THE ENTOMOLOGICAL SOCIETY OF AMERICA

LIST OF MEMBERS

(March, 1946)

In this list, which is arranged alphabetically, members are given in lower case type, Fellows in small caps and Honorary Fellows in capitals. The year of admission to membership is given before the name, and of election to Fellowship and Honorary Fellowship in parenthesis following the address. Names of Life Members are indicated by asterisk (*) and the special field of work in italics. Ch. indicates Charter Member, 1906.

A

'39. Aamodt, T. L., State Entomologist's Office, University Farm, St. Paul, Minn.
'39. Ackermann, Otto, 639 Walnut Street, Irwin, Pa. *Lepidoptera.*
'27. Adams, C. F., State Board of Health, Jefferson City, Mo. (F. '29). *Diptera.*
'40. Ahrens, Carsten, 3461 Harrisburg St., Pittsburgh 4, Pa. *Odonata.*
'10. Alexander, Charles P., Massachusetts State College, Amherst, Mass. (F. '20). *Tipulidae.*
'33. Alexander, E. Gordon, Dept. of Biology, Univ. of Colorado, Boulder, Colo. *Orthoptera.*
'13. Allee, W. C., Zoology Building, Univ. of Chicago, Chicago, Ill. (F. '39). *Behavior.*
'25. Allen, H. W., Box 150, Moorestown, N. J. (F. '40). *Tiphiidae, Tachinidae.*
'42. Allen, Theodore, 2520 Mulberry Ave., Muscatine, Iowa.
'32. Amos, John M., 403 State Office Bldg., Nashville 3, Tenn. *Coccidae, Cerambycidae.*
'30. Anderson, Edwin J., Frear Laboratory, State College, Pa. *Beekeeping.*
'29. Anderson, Lauren D., Virginia Truck Exper. Sta., P. O. Box 2160, Norfolk 1, Va. *Gerridae.*
'37. Anderson, William H., Room 429, U. S. National Museum, Washington 25, D. C. *Coleopterous larvae.*
'39. Andre, Floyd, Office of Exper. Sta., U. S. D. A., Washington, D. C. *Thysanoptera.*
'37. Anduze, Pablo J., Instituto Nacional de Higiene, Ministerio de Sanidad y Asistencia Social, Caracas, Venezuela. *Culicidae.*
'32. Annand, P. N., Bur. of Ent. and Pl. Quar., Washington, D. C. (F. '39). *Aphids.*
'28. App, Bernard A., Box 215, Burgaw, N. C. *Economic Entomology.*
'40. Archer, Allan F., 312 East Vine St., Decatur, Ala. *Arachnida.*
'23. Armstrong, T., Ent. Lab., Vineland Sta., Ontario, Canada. *Scarabaeidae.*
'36. Ashton, Donald F., 2711 Van Dyke Ave., Raleigh, N. C. *Culicidae.*
'37. Assmuth, Rev. Joseph, Fordham Univ., New York, N. Y. *Isoptera.*
'42. Atkins, Edward L., Jr., Route 1, Smithshire, Ill.
'34. Au, Sung Hin, 1911 Dole St., Honolulu 33, Hawaii. *Aphids.*
'33. Avinoff, A., Hidden Valley, Locust Valley, Long Island, N. Y. (F. '39). *Lepidoptera.*

B

'37. Babers, Frank H., P. O. Box 3391, Orlando, Fla. *Physiology.*
Ch. *Back, E. A., Bur. of Ent. and Pl. Quar., Washington, D. C. (F. '38). *Asilidae, Aleyrodidae.*
'39. Badertscher, A. Edison, 103 Bonnie Hill Road, Towson, Baltimore 4, Md. *Insecticides.*
'21. Baerg, W. J., Univ. of Arkansas, Fayetteville, Ark. (F. '32). *Poisonous Arthropods.*

'30. *Bailey, J. W., 27 Willway Road, Richmond, Va. *Myriapoda.*
'11. BAKER, A. C., Apartado Number 3, Colonia Anahuac, D. F., Mexico. (F. '29). *Aphididae, Aleyrodidae.*
'22. Baker, Howard, Bur. of Ent. and Pl. Quar., Washington 25, D. C. *Apple and Pecan Insects.*
'36. Baker, Walter C., Carter Memorial Laboratory, P. O. Box 547, Savannah, Ga. *Toxicology.*
'28. BALCH, R. E., Dominion Ent. Lab., Fredericton, New Brunswick, Canada. (F. '44). *Forest Insects.*
'20. BALDUF, W. V., 308 Entomology Bldg., Univ. of Illinois, Urbana, Ill. (F. '40). *Entomophagous Insects.*
'45. Ball, William Howard, Box 392, College Park, Md.
'43. Balock, John W., Laboratorio Entomologico, Apartado 3, Colonia Anahuac, D. F., Mexico.
'38. Ballou, Charles H., Instituto Experimental de Agricultura, El Valle, Distrito Federal, Venezuela. *Economic Entomology.*
'08. BANKS, NATHAN, 103 Norfolk St., Holliston, Mass. (F. '14, H. F. '45).
Ch. BARBER, H. G., 143 East Third Ave., Roselle, N. J. (F. '30). *Hemiptera.*
Ch. BARBER, H. S., U. S. National Museum, Washington 25, D. C. (F. '28). *Coleoptera.*
'23. Bare, Clarence O., Box 7062, Richmond 21, Va. *Notonectidae.*
'26. BARNES, H. F., Rothamsted Exper. Sta., Harpenden, Herts, England. (F. '37). *Cecidomyiidae.*
'28. Barnes, O. L. Address unknown.
'43. Barnes, Ralph C., U.S.P.H.S., 605 Volunteer Bldg., Atlanta, Ga.
'40. Barnett, Herbert C., Univ. of Minnesota, Dept. of Entomology, University Farm, St. Paul, Minn.
'39. Barrett, John P., care of Armour & Co., Dept. of Chemical Research, Union Stock Yards, Chicago 9, Ill. *Calliphoridae.*
'41. Barrett, Paul H., 302 Cowley, East Lansing, Mich. *Aquatic Insects.*
'35. Barrett, W. L., Jr., Box 208, Dallas 1, Texas. *Diptera.*
'39. Bartlett, Lawrence M., Fernald Hall, Massachusetts State College, Amherst, Mass. *Ephemeroptera.*
'18. BASINGER, A. J., Citrus Experiment Sta., Riverside, Calif. (F. '41). *Calliphoridae.*
'31. BATES, MARSTON, Rockefeller Foundation, Apartado 757, Villavicencio, Colombia, (F. '40). *Diptera, Trypetidae.*
'24. BEAMER, RAYMOND H., 1000 Missouri St., Lawrence, Kans. (F. '34). *Homoptera, Cicadellidae.*
'34. Beck, Elmer W., 626 Virginia Ave., Toledo 10, Ohio. *Parasites European Corn Borer.*
'29. Bedard, W. Delles, 335 Giannini Hall, Univ. of California, Berkeley, Calif. *Scolytidae, Braconidae.*
'20. Bedford, Hugh W., Gov. Ent., Agric. Res. Service, Ent. Sec., Wad Medani, Sudan, Africa.
'43. BEEBE, WILLIAM, New York Zoological Society, Zoological Park, Bronx Park, New York, N. Y. (F. '44).
'42. Belkin, John N., Dept. of Entomology, Agr. Exp. Sta., New Brunswick, N. J.
'25. BELL, ERNEST L., 150-17 Roosevelt Ave., Flushing, N. Y. (F. '40). *Hesperiidae.*
'40. Benesh, Bernard, P. O. Box 159, North Chicago, Ill. *Lucanidae.*
Ch. Bentley, G. M., 64 Biology Bldg., Univ. of Tennessee, Knoxville 16, Tenn. *Orthoptera.*
'23. Benton, Curtis, 1216 Ball St., Lafayette, Ind.
'17. *BEQUAERT, JOSEPH C., Curator of Insects, Museum of Comparative Zoology, Cambridge, Mass. (F. '34.) *Vespidae, Tabanidae.*
'28. Berley, J. A., Div. of Ent., Clemson College, S. C. *Coccidae, Odonata.*
'43. Berner, Lewis, Dept. of Biology, Univ. of Florida, Gainesville, Fla.
'39. Berry, Paul A., American Consul, Montevideo, Uruguay. *Biological Control.*
'34. Bess, Henry A., 623 North Second St., Milwaukee 3, Wis. *Ecology, Forest Insects.*
Ch. BETTEN, CORNELIUS, 104 Corson Place, Ithaca, N. Y. (F. '37). *Trichoptera.*
'28. Bibby, F. F., Smithville, Miss. *Cicadidae.*

'38. *Bickley, William E., Jr., U. S. Public Health Service, 300 Essex Bldg., Norfolk 10, Va. *Chrysopidae.*
'25. Bigger, J. H., Natural Resources Bldg., Urbana, Ill. *Plant Resistance to Insect Attack.*
'30. Billings, Samuel C., 8407 Woodcliff Court, Silver Spring, Md. *Mothproofing.*
'13. BILSING, S. W., College Station, Texas. (F. '41). *Cerambycidae.*
Ch. BIRD, HENRY, 600 Milton Road, Rye, N. Y. (F. '30). *Noctuidae, Papaipema.*
Ch. BISHOPP, F. C., Bur. of Ent. and Plant Quar., Washington, D. C. (F. '28). *Ixodoidea, Siphonaptera, Anoplura.*
'24. BISHOPP, SHERMAN C., Dept. of Biology, Univ. of Rochester, Rochester, N. Y. (F. '43). *Arachnida.*
'25. Bissell, Theodore L., Experiment, Ga. *Aphididae, Curculionidae.*
'37. Blackburn, Norris D., Ohio Agric. Exp. Sta., Wooster, Ohio. *Chrysomelidae.*
Ch. BLAISDELL, F. E., 22 High St., Watsonville, Calif. (F. '24). *Tenebrionidae, Melyridae.*
'28. Blanchard, R. A., Box 32, Urbana, Ill. *Plant Resistance to Insect Attack.*
'32. Blanton, Franklin S., 3723 Holms Lane, Building 504, Parkfairfax, Alexandria, Va. *Trypetidae, Otitidae.*
'30. Blauvelt, Helen Hayden, care of William Savey, Lake Road, Ithaca, N. Y.
'28. Blauvelt, William E., Comstock Hall, Cornell Univ., Ithaca, N. Y.
'29. BOESEL, M. W., R. R. No. 2, Oxford, Ohio. (F. '43). *Chironomidae.*
'44. Bohart, George Edward, P. O. Box 213, Jacksonville, N. C.
'37. Bohart, Richard M., Division of Entomology, College of Agriculture, Davis, Calif. *Strepsiptera, Hymenoptera.*
'28. BORROR, DONALD J., Dept. of Zoology & Entomology, Ohio State Univ., Columbus 10, Ohio. (F. '43). *Odonata.*
'46. Boudreaux, H. Bruce, Dept. of Zoology, Louisiana State Univ., Box 8729, Baton Rouge 13, La. *Aphididae.*
'14. BOVING, ADAM G., U. S. National Museum, Washington 25, D. C. (F. '29, H. F. '41). *Coleopterous larvae.*
'42. Bowery, Thomas G., 214 Birmingham Ave., Avalon, Pittsburgh 2, Pa.
'33. Boyce, A. M., Citrus Exper. Sta., Riverside, Calif.
Ch. BRADLEY, J. C., Cornell Univ., Ithaca, N. Y. (F. '14). *Campsomeris, Vespidae, Scoliidae.*
'19. BRADLEY, G. H., Box 654, New Smyrna Beach, Fla. (F. '41). *Diptera, Culicidae.*
'37. Bradley, William G., 2256 Collingwood Ave., Toledo, Ohio. *Parasitic Hymenoptera.*
'23. Branch, Hazel E., Univ. of Wichita, Wichita 6, Kans. *Chironomidae Larvae.*
'25. Brandhorst, Carl T., 106 Lincoln St., Seward, Neb. *Wasps.*
Ch. BRAUN, ANNETTE F., R. R. No. 13, Box 41C, Cincinnati 30, Ohio. (F. '24). *Microlepidoptera.*
'26. BREAKEY, E. P., Western Washington Exper. Sta., Puyallup, Wash. (F. '43). *Cicadellidae.*
'37. Breland, Osmond P., Dept. of Zoology, Univ. of Texas, Austin, Texas. *Chalcidoidea.*
'29. Brindley, T. A., 822 East Eighth St., Moscow, Idaho. *Pea Weevil.*
'26. BRITTAIN, W. H., McDonald College P. O., Quebec, Canada. (F. '37). *Homoptera.*
'20. BROMLEY, STANLEY W., Scoffieldtoan Road, Stamford, Conn. (F. '37). *Asilidae.*
'40. Brookman, Bernard, 1728 N. W. 32nd Ave., Portland 10, Ore. *Diptera.*
'39. Brower, Auburn E., 5 Hospital St., Augusta, Me. *Lepidoptera, Catocala.*
'33. Brown, F. Martin, Fountain Valley School, Colorado Springs, Colo. (F. '44). *Pieridae of the Americas.*
'42. Brown, John H., Administration Bldg., Dept. of Public Health, Edmonton, Alberta, Canada.
'26. BROWN, W. J., Entomological Branch, Dept. of Agriculture, Ottawa, Canada. (F. '40). *Coleoptera.*
Ch. BRUES, C. T., Biological Lab., Harvard Univ., Cambridge, Mass. (F. '14). *Hymenoptera.*
'30. BRUNER, S. C., Estacion Agronomica, Santiago de las Vegas, Havana, Cuba. (F. '37). *Homoptera, Hemiptera of Cuba.*

'27. Brunson, Marvin Howard, Box 150, Moorestown, N. J.
'33. BRYANT, ELIZABETH B., Museum of Comparative Zoology, Cambridge 38, Mass. (F. '43). *Arachnida.*
'30. Bryant, Owen, Steamboat Springs, Colo. *Coccinellidae.*
'38. Bryce, P. I., Ent. Lab., Vineland Sta., Ontario, Canada. *Fruit Tree Insects.*
'45. Buchanan, William Dwight, 522 Remington St., Fort Collins, Colo.
'27. Buckell, E. R., Field Crop Insect Lab., P. O. Bldg., Kamloops, British Columbia, Canada. *Orthoptera, Odonata.*
Ch. *BUENO, J. R. DE LA TORRE, 925 East Sixth St., Tucson, Ariz. (F. '28). *Aquatic Hempitera, Heteroptera.*
'31. Bugbee, Robert E., Biological Lab., Univ. of Rochester, Rochester 3, N. Y. *Eurytomidae.*
'38. Bunn, Ralph W., 5615 Oakmont Ave., Bethesda 14, Md. *Fulgoridae, Curculionidae.*
'45. Buren, William F., Assistant Sanitarian (R), U. S. Public Health Service, P. O. Drawer 1246, Miami Beach, Fla.
Ch. BURGESS, A. F., 24 Franklin St., Greenfield, Mass. (F. '17). *Carabidae.*
'35. BURKS, B. D., 231 Natural History Survey, Urbana, Ill. (F. '44). *Chalcididae.*
'27. *Burrell, R. W., Bur. of Ent. and Plant Quar., Box 3391, Orlando, Fla. *Thynnidae, Tiphiidae.*
'35. Bussart, J. Everett, 215 W. Harrison St., Wheaton, Ill. *Tachinid Biology.*
'30. BUTT, F. H., Cornell Univ., Ithaca, N. Y. (F. '40).
'20. Buys, John L., Dept. of Biology, St. Lawrence Univ., Canton, N. Y. *Homoptera, Cicadellidae.*
'36. Buzicky, Albert W., 215 Montrose Lane, St. Paul, Minn. *Chyphotes.*
'24. BYERS, C. FRANCIS, Dept. of Biology, Univ. of Florida, Gainesville, Fla. (F. '41). *Odonata.*

C

'35. *Caldwell, John S., 535 South Court St., Circleville, Ohio. *Fulgoridae, Psyllidae.*
Ch. CALVERT, PHILIP P., P. O. Box 14, Cheyney, Pa. (F. '07, H. F. '39). *Odonata.*
'28. CAMPBELL, FRANK LESLIE, The Scientific Monthly, Smithsonian Institution Bldg., Washington 25, D. C. (F. '34). *Toxicology.*
'13. CAMPBELL, ROY E., 1208 East Main, Alhambra, Calif. (F. '41).
'14. *Capp, S. B., Box 2054, Philadelphia, Pa.
'40. Capps, Hahn W., Division of Insect Identification, U. S. National Museum, Washington 25, D. C. *Geometridae.*
'33. CARPENTER, F. M., Museum of Comparative Zoology, Harvard Univ., Cambridge, Mass. (F. '38). *Mecoptera, Neuroptera.*
'26. Carpentier, Fritz, Institute of Ed. Van Veneden, 10 Rue Vivegnis, Liege, Belgium. *Morphology.*
'31. Carruth, Laurence A., Div. of Ent., New York Agric. Exper. Sta., Geneva, N. Y. *Meloidae.*
'22. CARTER, WALTER, P. O. Box 3166, Honolulu, Hawaii, (F. '38). *Insect Transmission of Plant Diseases.*
'26. CARTWRIGHT, O. L., State Board of Health, 409 Wade Hampton Office Bldg., Columbus 10, S. C. *Scarabaeidae.*
'26. Cartwright, William B., Box 495, Lafayette, Ind. *Hessian Fly.*
'45. Castillo, Robert Levi, P. O. Box 759, Guayaquil, Ecuador, South America.
'22. CHAMBERLAIN, JOSEPH C., P. O. Box 278, Forest Grove, Ore. (F. '38). *Chelonethida.*
Ch. CHAMBERLIN, R. V., Univ. of Utah, Salt Lake City, Utah. (F. '17). *Myriapoda, Arachnida.*
'18. Chambers, Ernest L., Room 424 Northeast, State Capitol, Madison, Wis.
'14. Champion, H. G., Dept. of Forestry, Imperial Forestry Institute, Univ. of Oxford, Oxford, England. *Coleoptera.*
'15. Chapman, James W., Silliman Institute, Dumaguete, Philippine Islands. *Ants of P. I.*
'41. Chickering, A. M., 206 South Mingo St., Albion, Mich. *Arachnida.*
'13. Childs, Leroy, Hood River, Ore. *Apple and Pear Insects.*
'30. Christenson, L. D., Bur. of Ent. and Pl. Quar., P. O. Box 1066, Riverside, Calif. *Aptera, Myriapoda.*

'27. Clagg, C. F., Barnstable, Mass. *Mecoptera, Hemiptera.*
'22. Clark, Charles A., Box 576, Toledo 10, Ohio. *Odonata, Ichneumonidae.*
'34. Clarke-Macintyre, William, 142 Prospect St., East Orange, N. J. *Rhopolocera of Ecuador.*
'14. CLAUSEN, CURTIS P., Bur. of Ent. and Pl. Quar., Washington, D. C. (F. '37). *Insect Parasites.*
'42. Cobb, William R., 1624 Rincon Drive, Whittier, Calif.
'07. COCKERELL, T. D. A., 908 Tenth St., Boulder, Colo. (F. '08, H. F. '37). *Bees, Fossil Insects.*
'39. COLCORD, MABEL, 2520 Fourteenth St., N. W., Washington 9, D. C. (F. '43). *Bibliography.*
'28. COLE, ARTHUR C., JR., Dept. of Zoology, Univ. of Tennessee, Knoxville, Tenn. (F. '43). *Formicidae.*
'16. COLE, F. R., P. O. Box No. 6, Redlands, Calif. (F. '38). *Diptera, Hymenoptera.*
'29. Collins, Donald L., 20 Circle Lane, Albany 3, N. Y. *Coleoptera.*
'44. Coman, Edward L., 26 Lake St., Wakefield, R. I.
'21. Compton, Charles C., 513 South Pine St., Champaign, Ill. *Greenhouse and Truck Insects.*
'29. Conklin, J. G., Dept. of Entomology, Univ. of New Hampshire, Durham, N. H. *Coccinellidae.*
'35. Connell, Walter A., Dept. of Entomology, Univ. of Delaware, Newark, Del. *Diptera.*
'44. Conroy, John H., 492 Ridgewood Road, Maplewood, N. J.
Ch. Cook, Mel T., 255 Barnard Road, Larchmont, N. Y. *Entomogenous Fungi.*
'19. COOK, WILLIAM C., 219 Newell St., Walla Walla, Wash. (F. '38). *Noctuidae.*
'10. COOLEY, R. A., U. S. Public Health Service, Hamilton, Mont. (F. '24). *Ixodidae, Ixodiphiginae.*
'36. Cooper, James Furman, Univ. Exper. Farm, Kearneysville, W. Va. *Pear Psylla.*
'40. Cooper, Robert H., 620 North McKinley, Muncie, Ind.
'39. Cope, Oliver B., North Rotunda, Museum Bldg., Stanford Univ., Calif.
'32. Cory, Ernest N., State Entomologist, College Park, Md.
'21. COSTA-LIMA, ANGELO M. DA., Instituto Oswaldo Cruz, Caixa Postal 926, Rio de Janeiro, Brazil. (F. '39, H. F. '43). *Economic Entomology.*
'15. COTTON, RICHARD T., 343 North Fourteenth St., Manhattan, Kans. (F. '37). *Curculionid Larvae.*
'35. Couture, Philip, 6 Mill Road, Durham, N. H.
'46. Cowan, Frank A., 2201 Schulle St., Austin, Texas. *Biology Muscoids.*
'46. Cox, Sam, 127 North Tenth Ave. East, Duluth 5, Minn.
'11. *CRAMPTON, G. C., 86 Pleasant St., Amherst, Mass. (F. '17). *Morphology.*
'39. Crandall, Robert H., W. Los Alto Road, Route 6, Box 548, Tucson, Ariz. *Hymenoptera.*
'33. Creighton, John T., Univ. of Florida, Gainesville, Fla. *Economic Entomology.*
Ch. CRESSON, E. T., JR., 11 Amherst Ave., Swarthmore, Pa. (F. '24). *Ephydridae, Micropezidae.*
'38. Crowell, H. H., 2454 S.W. Sherwood Drive, Portland 1, Ore. *Physiology.*
'15. CURRAN, C. H., American Museum of Natural History, 77th St. and Central Park W., New York, N. Y. (F. '34). *Diptera.*
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'42. Curtis, William E., 311 Dryden Road, Ithaca, N. Y.
'43. Cutkomp, Laurence K., Dept. of Health and Safety, Tennessee Valley Authority, Wilson Dam, Ala.
'21. Cutright, Clifford R., Agric. Exper. Sta., Wooster, Ohio. *Aphidae.*

D

'35. *Daggy, Richard H., Agric. Exper. Sta., Univ. Farm, St. Paul, Minn. *Ephemeroptera.*
'42. Dailey, Ervin F., 825 East 78th St., Seattle 5, Wash. *Myriapoda.*
'42. Dalmot, Herbert T., Dept. of Entomology, Cornell Univ., Ithaca, N. Y.
'43. Dambach, Charles A., Dept. of Zool. and Ent., Ohio State Univ., Columbus 10, Ohio.

'44. d'Andretta, Carlos, Jr., Escola Paulista de Medicina Rua Botucatai 720, San Paulo, Brazil.
'25. DARLINGTON, P. J., JR., Museum of Comparative Zoology, Cambridge, Mass. (F. '38). *Adephaga, Dryopidae.*
'30. DAVIDSON, RALPH H., Dept. of Entomology, Ohio State Univ. ,Columbus 10, Ohio. (F. '43). *Cicadellidae.*
'43. Davidson, Thomas R., Dept. of Entomology, Univ. of Alberta, Edmonton, Alberta, Canada.
'22. Davis, E. W., Box 218, Union Gap, Wash. *Cicadellidae.*
Ch. DAVIS, J. J., Purdue Univ., Lafayette, Ind. (F. '17). *Aphididae, Lachnosterna.*
'13. DEAN, GEORGE A., Kansas State College, Manhattan, Kans. (F. '17). *Economic Entomology.*
'33. Dean, R. W., Cottage Road, Poughkeepsie, N. Y. *Rhynchophora.*
'36. Dearolf, Kenneth, Box 525, R. R. No. 1, Dayton 5, Ohio. *Cave Insects.*
'25. Deay, Howard O., Dept. of Entomology, Purdue Univ., Lafayette, Ind. *Coreidae, Tenagobia, Micronecta.*
'38. DeBach, Paul H., Univ. of California, Cirtus Exper. Sta., Riverside, Calif. *Chalcidoidea.*
'24. Decker, George C., Natural History Survey, Urbana, Ill. *Stalk Borers, Crambus.*
'24. DeCoursey, R. M., Univ. of Connecticut, Storrs, Conn. *Hemiptera.*
'29. DeLeon, Donald, Box 217, Lafayette, Callf. *Scolytidae.*
'14. DELONG, D. M., Dept. of Entomology, Ohio State Univ., Columbus 10, Ohio. (F. '30). *Cicadellidae.*
'36. Del Ponte, Edwardo, Instituto Bacteriologico, Calle Velez Sarsfield 563, Dept. Nacional de Hygiene, Buenos Ayres, Argentina. *Parasitic Insects.*
'34. *DENNING, DONALD G., U. S. Public Health Service, Quar. Sta., Miami Beach 39, Fla. (F. '43). *Trichoptera, Corethrinae.*
'37. Dennis, Clyde A., Tusculum College, Greeneville, Tenn. *Formicidae.*
'34. *Deonier, C. C., Box 3391, Orlando, Fla. *Muscidae.*
'44. Detjen, Gustav H. H., 303 West 42nd St., New York 18, N. Y.
'27. Dicke, Ferdinand F., Box 576 M. O., Toledo, Ohio. *Harmolita Parasites.*
'39. Dickson, Robert C., Dept. of Ent., Citrus Exper. Sta., Riverside, Calif. *Aphididae.*
'22. DIETRICH, HENRY, Comstock Hall, Cornell Univ., Ithaca, N. Y. (F. '43). *Coleoptera.*
'35. Dillon, Lawrence S., Reading Public Museum and Art Gallery, Reading, Pa. *Cerambycidae.*
'24. Dills, L. E., Dept. of Zoology and Entomology, Penn. State College, State College, Pa.
'26. Dirks, C. O., 32 Coburn Hall, Univ. of Maine, Orono, Me. *Biology of Lepidoptera.*
'31. *Ditman, L. P., Univ. of Maryland, College Park, Md. *Ecology.*
'27. *Doak, K. D., Route A., Crown Point, Ind. *Gelechiidae.*
'36. *Dodge, Harold R., Box 436, Rt. 3, Montgomery, Ala. *Scolytidae.*
'22. DOERING, KATHLEEN C., Dept. of Ent., Univ. of Kansas, Lawrence, Kans. (F. '35). *Cercopidae, Fulgoridae.*
'41. Dorsey, Carl K., 437 Woodlawn Ave., Webster Groves, Mo. *Immature Coleoptera.*
'37. Dorst, Lt. Col. Howard E., U.S.A.C. Campus, Logan, Utah. *Cicadellidae.*
'22. Doucette, Charles F., Box 458, Sumner, Wash. *Ornamental Insects.*
'23. Douglass, J. R., Box 1100, Twin Falls, Idaho.
'45. Doutt, Richard L., Univ. of California, Citrus Exper. Sta., Riverside, Calif.
'28. DOVE, W. E., 2716 Belleview Ave., Cheverly, Md. (F. '40). *Animal Parasites.*
'31. Dow, Richard, Box 135, Berkeley, Calif. *Sphecoid Wasps.*
'22. Dowden, Philip B., 56 Hillhouse Ave., New Haven, Conn. *Parasitic Hymenoptera.*
'22. DRAKE, CARL J., Iowa State College, Ames, Iowa. (F. '31). *Tingitidae.*
'37. Dreisbach, Robert R., 301 Helen St., Midland, Mich. *Hymenoptera.*
'31. Driggers, Byrley F., Agric. Exper. Sta., New Brunswick, N. J. *Economic Entomology.*
'38. Drolet, Marcel, 95 Stefoy Road, Quebec, Quebec, Canada. *Cerambycidae.*
'45. DuChanois, F. R., 2154 Lincoln Way, Ames, Iowa.

'26. Dunavan, David, 116 North Clemson Ave., Clemson, S. C. *Haliplidae.*
'23. DUNCAN, CARL D., Box 4, Stanford Univ., Calif. (F. '41). *Vespidae, Bembicidae.*
'28. Dunnam, E. W., Box 8, Leland, Miss. *Cotton Resistance to Insects.*
'14. Dusham, E. H., 607 North Burrowes St., State College, Pa. *Coleoptera.*
'43. Dybas, Henry S., Division of Insects, Chicago Natural History Museum, Chicago 5, Ill. *Ptiliidae, Nanosellinae.*

E

Ch. Easton, Norman S., 458 High St., Fall River, Mass. *Coleoptera.*
'44. Eaton, Charles B., Div. of Forest Insects, Bureau of Entomology and Plant Quarantine, Beltsville, Md. *Forest Insects.*
'46. Eberlein, George, West Concord, Mass.
'31. ECKERT, J. E., University Farm, Univ. of Calif., Davis, Calif. (F. '43). *Beekeeping.*
'36. Eddy, C. Brayton, New York Zoological Society, Bronx Park, New York 62, N. Y.
'23. EDDY, C. O., Niagara Sprayer & Chemical Co., Middleport, N. Y. (F. '31).
'40. Elishewitz, Harold, 953 Goodrich Ave., St. Paul 5, Minn. *Ixodoidea.*
'24. Elmore, J. C., 1208 East Main, Alhambra, Calif. *Truck Crop Insects.*
'19. EMERSON, ALFRED E., Dept. of Zoology, Univ. of Chicago, Chicago, Ill. (F. '37). *Isoptera, Termitophiles.*
'38. Emerson, K. C., Cromwell, Okla. *Mallophaga.*
'25. Enders, Howard E., 249 Littleton St., West Lafayette, Ind. *Mallophaga.*
'38. Epstein, Erwin J., 6302 Dieterle Drive, Rego Park, Long Island, N. Y. *Odonata.*
'43. Esselbaugh, Charles O., 703 West Nevada, Urbana, Ill.
'10. ESSIG, E. O., Univ. of California, Berkeley, Calif. (F. '26). *Aphididae, Coccidae.*
'29. Evans, J. Harwood, Oshkosh High School, Oshkosh, Wis. *Phymatidae.*
'30. Everly, Ray T., Agric. Exper. Sta., Purdue Univ., West Lafayette, Ind. *Carabidae.*
'10. EWING, HENRY E., U. S. National Museum, Washington, D. C. (F. '28). *Acarina.*
'18. EYER, JOHN R., State College, N. M. (F. '38). *Cicadellidae, Chermidae.*

F

'32. FAIRCHILD, GRAHAM BELL, 651 Ancon, 62, Panama. (F. '43). *Culicidae, Tabanidae.*
'40. Fallis, A. Murray, Ontario Research Foundation, 43 Queens Park, Toronto, Ontario, Canada. *Insect Parasites.*
'35. Falls, Olive, 5535 Dorchester Ave., Chicago, Ill. *Termite Biology.*
'30. Farquhar, Donald W., 296 Ames St., Lawrence, Mass. *Lepidoptera of New England.*
'17. Fattig, P. W., Box 788, Emory University, Ga.
'45. Faure, Gabriel O., Dept. Sanidad Vegetal, Casilla 4647, Santiago, Chile, S.A.
'34. Fay, Richard William, 417 East 53rd St., Savannah, Ga. *Insect Physiology.*
'36. Fenton, Alfred S., 1002 Second National Bank Bldg., Houston, Tex.
Ch. FERNALD, H. T., 1128 Oxford Road, Winter Park, Fla. (F. '14, H. F. '37). *Sphecidae.*
'14. FERRIS, G. F., Natural History Museum, Stanford University, Calif. (F. '34). *Coccidae, Mallophaga, Anoplura, Diptera.*
'35. Field, William D., Bur. of Ent. and Plant Quar., Washington, D. C. *Arctiidae, Lycaenidae.*
Ch. Field, William L. W., 75 Vose's Lane, Milton 87, Mass.
'31. Filmer, Robert Sterling, Rutgers University, New Brunswick, N. J. *Hymenoptera.*
'35. Fisher, Elizabeth G., 20 Blythewood Road, Baltimore 10, Md. *Odonata, Mycetophilidae.*
'36. Fisk, Frank Wilbur, State Dept. of Health, Malaria Control in War Areas, Louisville 2, Ky. *Culicidae.*

'30. FLANDERS, STANLEY E., Citrus Exper. Sta., Riverside, Calif. (F. '37). *Biology of Chalcidoidea.*
'22. Fletcher, Frank C., Room 301, 100 Gibbs St., Rochester, N. Y. *Coleoptera.*
'31. Fletcher, Fred W., Dept. of Biochemistry, Dow Chemical Co., Midland, Mich. *Insecticides.*
'43. Flock, Robert A., P. O. Box 1297, Phoenix, Ariz.
'24. FLUKE, C. L., King Hall, Univ. of Wisconsin, Madison 6, Wis. (F. '35). *Syrphidae.*
'42. Fluno, John A., Quincy, Kans.
'45. Fontaine, Russell E., 449 Mill St., Worcester 2, Mass.
'38. Forbes, James, 2986 Marion Ave., New York 58, N. Y. *Formicidae.*
'08. *FORBES, WILLIAM T. M., Cornell University, Ithaca, N. Y. (F. '30). *Lepidoptera, Neuropteroids.*
'30. Foster, Charles E., Colgate University, Hamilton, N. Y. *Coccidae.*
'11. FRACKER, S. B., Bur. of Ent. and Plant Quar., U. S. Dept. of Agric., Washington, D. C. (F. '34). *Coreidae.*
'23. FREEBORN, STANLEY B., 101 Giannini Hall, Univ. of California, Berkeley, Calif. (F. '38). *Culicidae.*
'22. FRIEND, ROGER B., Agric. Exper. Sta., 153 Huntington St., New Haven, Conn. (F. '38). *Diptera.*
'44. Frizzell, Harriet Exline, Dept. of Zoology, Univ. of Texas, Austin 12, Tex. *Araneida.*
'40. Froeschner, Richard C., 5102a Lotus Ave., St. Louis, 13, Mo. *Hemiptera.*
'40. Fronk, W. Don, Virginia Agricultural Exp. Sta., Blacksburg, Va.
Ch. FROST, C. A., 67 Henry St., Framingham, Mass. (F. '44). *Coleoptera.*
'41. Frost, Florence M., 1376 Shattuck Ave., Berkeley 7, Calif. *Diptera.*
'14. FROST, STUART W., 465 East Foster Ave., State College, Pa. (F. '35). *Agromyzidae, Hispinae.*
Ch. FULLAWAY, D. T., Agricultural Board, Box 3319, Honolulu, Hawaii. (F. '40). *Parasitic Hymenoptera.*
'16. FULTON, B. B., State College, Raleigh, N. C. (F. '32). *Orthoptera.*
'11. FUNKHOUSER, WILLIAM D., Univ. of Kentucky, Lexington, Ky. (F. '20). *Membracidae.*
'45. Furman, Deane P., 197 Amherst Ave., Berkeley 8, Calif.
'40. Furniss, Robert L., 445, U. S. Court House, Portland, Ore. *Forest Entomology.*

G

Ch. GAHAN, A. B., U. S. National Museum, Washington, D. C. (F. '28). *Chalcidoidea.*
'16. GAIGE, F. M., Museum of Zoology, Univ. of Michigan, Ann Arbor, Mich. (F. '38). *Formicidae.*
'46. Galindo, Pedro, Campana Anti-Malarica, Ministerio de Pr. Social, Panama, Republic of Panama.
'22. Garlick, W. G. P., Vineland Sta., Ontario, Canada. *Tenthrediniodea.*
'14. GARMAN, PHILIP, Agric. Exp. Sta., New Haven, Conn. (F. '38). *Odonata, Acarina.*
'46. Gaul, Albro, 401 Washington Ave., Brooklyn 5, N. Y.
'39. Gauthier, Georges, Entomologiste, Ministere de l'Agriculture, Quebec, Canada.
'45. Gelfand, Henry M., 41–13 162nd St., Flushing, N. Y. *Mosquitoes & Medical Entomology.*
'16. GENTNER, LOUIS G., 22 Groveland Ave., Medford, Ore. (F. '44). *Halticinae.*
'45. Gerberich, John B., Dept. of Zoology, Ohio State Univ., Columbus 10, Ohio.
Ch. GERHARD, WILLIAM J., Chicago Museum of Natural History, Chicago 5, Ill. (F. '43). *Hemiptera.*
'44. Gerlach, Charles F., Michigan Chemical Corp., St. Louis, Mich.
'22. Gerry, Bertram I., Box 28, Wellesley Hills, Mass. *Culicidae and Chironomidae.*
'32. GERTSCH, WILLIS J., 42 Wyckoff Ave., Ramsey, N. J. (F. '40). *Arachnida.*
Ch. GIBSON, ARTHUR, Apt. 6, 30 Cooper St., Ottawa, Ontario, Canada. (F. '17).
'14. Gibson, E. H., Trinity Episcopal Church, Galveston, Tex. *Hemiptera.*

'44. Gibson, W. W., LeMoyne College, Memphis, Tenn.
'41. Gillogly, Lorin R., 5462 Fourteenth Ave., Sacramento 17, Calif. *Nitidulidae.*
'21. Gilmer, Paul M., Coastal Plains Exper. Sta., Tifton, Ga. *Cotton Insects.*
'16. GLASER, R. W., Rockefeller Medical Research Institute, Princeton, N. J. (F. '41). *Insect Diseases.*
'11. Glasgow, Hugh, Exper. Sta., Geneva, N. Y.
'11. Glasgow, Robert D., State Education Bldg., Albany, N. Y. *Forest Insects.*
'38. Gleissner, Bruce D., 20 Ridge Road, Cos Cob, Conn. *Insect Physiology.*
'39. Glick, Perry A., Box 1218, Waco, Texas. *Cotton Insects, Lepidoptera.*
'33. Glover, L. C., Box 486, T. Hall, Durham, N. H. *Carabidae, Cerambycidae.*
'30. Glover, Louise Haas, Shell Agricultural Lab., Modesto, Calif. *Carabidae.*
'45. Goelbert, Raymond, 82-01 164th Place, Jamaica 2, N. Y.
'43. Gogel, K. Address unknown.
'46. Goldberg, Alma Rutledge, 621 St. Johns Road, Baltimore 10, Md.
'30. GOOD, NEWELL E., 9813 Bristol Ave., Silver Spring, Md. (F. '43) *Siphonaptera.*
'44. Goodwin, M. H., Jr., Assistant Sanitarian, U.S.P.H.S., 605 Volunteer Bldg., Atlanta 3, Ga.
'36. Gouck, Harry K., 6 Palm Ave., Savannah, Ga. *Plecoptera.*
'31. Gould, George E., Purdue Univ., Lafayette, Ind. *Rhagovelia, Semiaquatic Hemiptera.*
'39. Graham, Lewis T., Bessmay, Tex. *Membracidae.*
'17. GRAHAM, SAMUEL A., Univ. of Michigan, Ann Arbor, Mich. (F. '32). *Forest Insects.*
'22. GRANOVSKY, A. A., Div. of Entomology, University Farm, St. Paul 8, Minn. (F. '35). *Aphiidae.*
'25. Grant, U. S. IV, Natural History Museum, Balboa Park, San Diego, Calif.
'17. Green, J. W., R. D. No. 2, Easton, Pa. *Cantharidae, Lampyridae.*
'14. GREENE, CHARLES T., 4805 Guilford Road, College Park, Md. (F. '46). *Diptera.*
'43. Gregg, Robert E., Dept. of Biology, Univ. of Colorado, Boulder, Colo.
'36. *GRESSITT, J. LINSLEY, Natural History Survey and Museum, Lingnan Univ., Canton, China. *Coleoptera.*
'34. Griffith, Capt. Melvin E., P. H. S. No. 3155, Malaria Control in War Areas, State Health Dept., Oklahoma City, Okla. *Alconeura, Collembola.*
'42. Griffiths, James T., Jr., Citrus Exper. Sta., Lake Alfred, Fla.
'33. *GURNEY, ASHLEY B., Div. of Insects, U. S. National Museum, Washington, D. C. (F. '43). *Orthoptera, Zoroptera, Corrodentia.*
'16. GUYTON, T. L., 2310 Chestnut St., Harrisburg, Pa. (F. '41). *Aphididae.*

H

'25. Haber, Vernon R., 355 West Ridge Ave., State College, Pa. *Orthoptera.*
'23. Hadley, C. H., Bur. of Ent. & Plant Quar., Moorestown, N. J. *Japanese Beetle.*
'24. HAEUSSLER, GILBERT J., Bur. of Ent. & Plant Quar., Washington 25, D. C. (F. '41). *Ichneumonidae, Braconidae.*
'14. HAGAN, HAROLD R., Dept. of Biology, College of the City of New York, 139th and Convent Ave., New York 31, N. Y. (F. '38). *Embryology.*
'45. Hagen, Ellsworth, 2647 22nd Ave., Oakland 6, Calif.
'25. HALL, DAVID G., 593 Arlington Village, Arlington, Va. (F. '41). *Sarcophagidae, Diptera.*
'41. Hambleton, Edson J., Office of Foreign Agricultural Relations, U. S. Dept. of Agric., Washington 25, D. C. *Tingitidae* (Neotropical).
'14. Hamilton, Clyde C., New Jersey Agric. Exper. Sta., New Brunswick, N. J.
'22. Hamner, A. L., Box 223, State College, Miss. *Aphididae, Phylloxera.*
'37. Handford, Richard H., Box 250, Brandon, Manitoba, Canada. *Acrididae.*
'44. Hansens, Elton J., New Jersey Agric. Exper. Sta., New Brunswick, N. J.
'39. Hanson, John F., 167 Lowell Ave., Newtonville 60, Mass. *Plecoptera.*
'39. Harden, Capt. Philip H., U.S.P.H.S., State Board of Health, Box 630, Jackson 113, Miss. *Plecoptera.*
'37. Hardy, D. Elmo, Dept. of Zoology & Entomology, Iowa State College, Ames, Iowa. *Pipunculidae, Bibionidae.*

'36. Harmston, Fred Carl, 117 East 27th South, Salt Lake City, Utah. *Dolichopodidae.*
'07. *HARNED, R. W., Bur. of Ent. & Plant Quar., Washington 25, D. C. (F. '27).
'33. Harper, Lawrence C., R. R. No. 1, Lafayette, N. Y. *Diptera.*
'29. HARRIES, F. H., 151 West Eleventh Ave., Columbus, Ohio. (F. '43). *Ecology, Physiology.*
'23. HARRIS, HALBERT M., Dept. of Zoology, Iowa State College, Ames, Iowa. (F. '37). *Hemiptera.*
'44. Harston, George B., Wyoming State Entomologist, P. O. Box 785, Powell, Wyoming.
'42. Hart, Thomas A., 5556 Kimbark Ave., Chicago, Ill.
'39. Hartnack, Hugo, 324 North Fourth St., Tacoma, Wash.
'21. Hartzell, Albert, Boyce Thompson Institute, 1086 North Broadway, Yonkers 3, N. Y. *Cicadellidae.*
'07. Hartzell, F. Z., Agric. Exper. Sta., Geneva, N. Y. *Coleoptera.*
Ch. Haseman, Leonard, Whitten Hall, Dept. of Entomology, Univ. of Missouri, Columbia, Mo. *Psychodidae.*
'32. HASKINS, CARYL P., Green Acre Lane, Westport, Conn. (F. '44). *Formicidae, Hymenoptera.*
'20. HATCH, MELVILLE H., Dept. of Zoology, Univ. of Washington, Seattle 5, Wash. (F. '38). *Coleoptera.*
'38. Hathaway, Edward S., Dept. of Zoology, Tulane Univ., New Orleans, La. *Ecology of Marsh Insects.*
'32. Haub, James G., Dept. of Zoology, Ohio State Univ., Columbus, Ohio. *Physiology.*
'39. Haude, William J., care of John Powell & Company, 1 Park Ave., New York, N. Y. *Culicidae.*
'30. Haug, Gordon W., Kelowna, British Columbia, Canada. *Formicidae.*
'27. Hawkins, J. H., Agric. Exper. Sta., Orono, Me. *Elaterid & Noctuid Larvae.*
'32. Hawley, I. M., P. O. Box 150, Moorestown, N. J. *Japanese Beetle.*
'35. Haydak, M. H., Div. of Entomology, University Farm, St. Paul 8, Minn. *Honeybee Nutrition.*
'19. HAYES, WILLIAM P., Entomology Bldg., Univ. of Illinois, Urbana, Ill. (F. '29). *Larvae.*
'31. Heaton, Robert R., 518 Architects & Builders Bldg., Indianapolis 4, Ind. *Fulgoridae, Homoptera.*
'34. Hendee, Esther, (Mrs. Kottke), 4044 Warwick Ave., Chicago 41, Ill. *Isoptera, Hymenoptera.*
'32. Henderson, Charles, 803 Forty-third Ave., Gulfport, Miss. *Parasites of Scale Insects.*
'31. HENDERSON, LYMAN S., Bur. of Ent. & Plant Quar., Beltsville Research Center, Beltsville, Md. (F. '43). *Curculionidae.*
'29. Hering, Paul E., Dept. of Biology, Carthage College, Carthage, Ill. *Economic Entomology.*
'25. HERMS, WILLIAM B., 112 Agriculture Hall, Univ. of California, Berkeley, Calif. (F. '29). *Medical Entomology.*
Ch. HERRICK, GLENN W., 219 Kelvin Place, Ithaca, N. Y. (F. '14). *Thysanoptera, Coccidae.*
'43. Hertig, Major Marshall, Sn.C., care of Headquarters P. C. D., APO 834, care of Postmaster, New Orleans, La.
'28. Hickman, J. R., Normal College, Ypsilanti, Mich. *Haliplidae.*
'08. HILTON, WILLIAM A., 1263 Dartmouth Ave., Claremont, Calif. (F. '39). *Symphyla, Pauropoda.*
'27. HINMAN, E. HAROLD, Health & Safety Dept., Tennessee Valley Authority, Wilson Dam, Ala. (F. '37). *Culicidae.*
'33. HINTON, HOWARD E., Dept. of Ent., British Museum (Natural History), Cromwell Road, London, S. W. 7, England. (F. '44). *Dryopidae.*
'27. Hockenyos, George L., 213 East Jefferson St., Springfield, Ill. *Economic Entomology.*
'38. Hodge, Charles 4th, Dept. of Biology, Temple Univ., Philadelphia, Pa. *Coleoptera.*
Ch. Hodgkiss, H. E., 147 West Park Ave., State College, Pa. *Eriophyiidae.*
'29. HODSON, A. C., Div. of Ent., Univ. Farm, St. Paul, Minn. (F. '43). *Ecology.*

'44. Hoff, C. Clayton, Dept. of Zoology, Colo. State College, Ft. Collins, Colo.
'43. Hoffmann, Anita, Apartado 8026, Mexico, D. F., Mexico.
'29. Hoffmann, Clarence H., Box 71, Bowie, Md. *Scarabaeidae.*
'20. HOFFMANN, WILLIAM E., Lingnan University, Canton, China. (F. '39). *Hemiptera.*
'35. Holway, Richard T., 9 Crescent St., Shrewsbury, Mass. *Termites.*
'38. Hoogstraal, Harry, 7815 South Park Ave., Chicago 19, Ill. *Morphology.*
'34. HORSFALL, WILLIAM R., Dept. of Entomology, Univ. of Arkansas, Fayetteville, Ark. (F. '43). *Culicidae.*
'34. Hoskins, W. M., 112 Agriculture Hall, Univ. of California, Berkeley, Calif. *Physiology.*
'24. Hough, W. S., Winchester, Va. *Apple Insects.*
Ch. HOUSER, J. A., Agric. Exper. Sta., Wooster, Ohio. (F. '31). *Coccidae.*
'39. Hovey, Charles L., Box 728, Eastern States Farmers Exchange, Hedrick Bldg., West Springfield, Me. *Aphiidae.*
'44. Hovanitz, William, Univ. of Michigan, Laboratory of Vertebrate Biology, Ann Arbor, Mich.
Ch. HOWARD, L. O., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '07, H. F. '24). *Chalcidoidea.*
'14. HOWARD, NEALE F., 151 West Eleventh Ave., Columbus, Ohio. (F. '44). *Mexican Bean Beetle.*
'39. Howland, A. F., 1208 East Main St., Alhambra, Calif. *Tomato Insects.*
'23. HUBBELL, THEODORE H., Dept. of Biology, Univ. of Florida, Gainesville, Fla. (F. '39). *Orthoptera.*
'20. HUCKETT, H. C., Long Island Vegetable Research Farm, Riverhead, Long Island, N. Y. (F. '38). *Muscidae.*
'44. Huffaker, Carl B., 1050 San Pablo Ave., Albany 6, Calif. *Mecoptera.*
'39. Hughes, John H., U.S.P.H.S., Division of Foreign Quarantine, Washington 14, D. C. *Chrysomelidae.*
'16. HUNGERFORD, H. B., 323 Snow Hall, Univ. of Kansas, Lawrence, Kans. (F. '27). *Aquatic Hemiptera.*
'43. Hunt, Charles R., Dept. of Zoology, Washington State College, Pullman, Wash.
'36. Hurlbut, Herbert S., West High St., Union City, Pa. *Culicidae.*
'38. Hutson, Ray, Dept. of Entomology, Michigan State College, East Lansing, Mich. *Insecticides.*
'42. Hutzel, John M., 124 Moncure Drive, Alexandria, Va.
'08. HYSLOP, JAMES A., Arsenal, Silver Spring, Md., (F. '35). *Elateridae.*

I

'31. IDE, F. P., Dept. of Zoology, Univ. of Toronto, Toronto 5, Ontario, Canada. (F. '40). *Ephemeroptera.*
'19. *ILLINGWORTH, J. F., Bishop Museum, Honolulu, Hawaii. (F. '40). *Muscoidea.*
'28. Ingram, J. W., Box 387, Houma, La. *Sugarcane Insects.*
'14. ISELY, DWIGHT, Box 3, University Station, Fayetteville, Ark. (F. '34). *Chrysomelidae, Curculionidae.*
'36. ISELY, F. B., 2835 West Gramercy, San Antonio, Tex. (F. '46). *Orthoptera.*
'27. Ives, J. D., Jefferson City, Tenn. *Cave Insects.*
'34. Ivy, Edward E., Box 1218, Waco, Tex.

J

'41. James, Brother Cyprian, Manhattan College, Spuyten Duyvil Parkway, New York 63, N. Y. *Psyllidae.*
'38. James, Freburn L., 3934 SCU, CME, Loma Linda, Calif. *Coleoptera.*
'31. JAMES, MAURICE T., Dept. of Entomology, Colorado State College, Fort Collins, Colo. (F. '40). *Stratiomyiidae.*
'30. Janes, Melvin J., Office, Ninth Service Command Engineers, Fort Douglas, Utah. *Economic Entomology.*
'35. Jaques, Harry E., 709 North Main, Mount Pleasant, Iowa. *Insect Ecology.*
'30. Jaynes, H. A., 117 Chatham St., Chatham, N. Y. *Tiphia of S. A.*
'10. Jennings, H. R., High School of Com., Hayes & Van Ness Ave., San Francisco, Calif. *Diptera.*

'41. Jensen, Dilworth D., Univ. of Hawaii Agric. Exper. Sta., Honolulu, T. H. *Psyllidae.*
'15. Jewett, H. H., Agric. Exper. Sta., Lexington, Ky. *Tobacco and Foreign Crop Insects.*
'43. Jodka, Joseph F. T., Comstock Hall, Cornell Univ., Ithaca, N. Y.
Ch. JOHANNSEN, O. A., 203 Parkway, Ithaca, N. Y. (F. '14, H. F. '39). *Diptera.*
'46. Johnson, Donald Ross, 6409 Tahoma Ave., Chicago 30, Ill.
'25. Johnson, Frank, 420 Lexington Ave., New York, N. Y.
'39. Johnson, John W., 1748½ Orange Ave., Costa Mesa, Calif. *Saturniidae.*
'27. Jones, Elmer T., 1204 Fremont, Manhattan, Kans. *Hessian Fly.*
Ch. JONES, FRANK M., 2000 Riverview Ave., Wilmington 47, Del. (F. '46). *Psychidae.*
'39. Jones, J. R. J. Llewellyn, "Arranmore," R. M. D. No. 1, Cobble Hill, British Columbia, Canada. *Ecology of Lepidoptera Larvae.*
'46. Jones, Jack D., Box 212, R. R. No. 1, Fort Collins, Colo. *Cicadidae.*
'41. Jones, Joseph W., Jr., Dept. of Zoology, Univ. of Tennessee, Knoxville, Tenn.
'45. Jones, Sarah Elizabeth, Dept. of Biology, Box 3716, Texas State College for Women, Denton, Tex.
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'40. Just, Theodore K., P. O. Box 126, Notre Dame, Ind.

K

'42. Kadner, Carl G., Loyola Univ., Los Angeles, Calif. *Hippoboscidae, Culicidae.*
'34. Kagy, J. Franklin, care of Dow Chemical Co., P. O. Box 245, Seal Beach, Calif. *Insect Toxicology.*
'26. Kamal, Mohammed, care of A. Moursi, Minister of Agriculture, Parasite Laboratory, Giza, Egypt. *Cotton Insects.*
'34. Kearns, Clyde W., Dept. of Entomology, Univ. of Illinois, Urbana, Ill. *Insecticides.*
'29. Keck, Chester B., Box 340, Honolulu, Hawaii. *Ecology.*
'14. KENNEDY, C. H., Dept. of Zoology, Ohio State Univ., Columbus 10, Ohio. (F. '27). *Odonata, Ants.*
Ch. Kincaid, Trevor, Univ. of Washington, Seattle, Wash. *Psychodidae, Dytiscidae.*
'12. KING, J. L., Box 150, Moorestown, N. J. (F. '32). *Biological Control.*
'23. KING, KENNETH M., Dominion Field Crop Insect Laboratory, Victoria, B. C. (F. '38). *Elateridae Larvae, Noctuidae.*
'28. KING, WILLARD V., Box 3391, Orlando, Fla. (F. '38). *Culicidae.*
'18. KINSEY, ALFRED C., Indiana Univ., Bloomington, Ind. (F. '28). *Cynipidae.*
'28. Kislanko, J. P., Box 88, Wiggins, Miss. *Aphididae.*
'38. Klots, Alexander B., Dept. of Biology, 17 Lexington Ave., New York, N. Y. *Lepidoptera.*
'45. Knapp, Virgil Robert, Zionsville, Ind.
'11. KNIGHT, H. H., Dept. of Zoology, Iowa State College, Ames, Iowa. (F. '28). *Hemiptera, Miridae.*
'40. Knight, Kenneth L., 4513 Gladwyne Drive, Bethesda 14, Md. *Geometrid Larvae.*
'24. KNOWLTON, GEORGE E., Utah State Agricultural College, Logan, Utah. (F. '40). *Aphididae.*
'32. KNULL, MRS. DOROTHY, 330 East Dunedin Road, Columbus 2, Ohio. (F. '43). *Cicadellidae, Cercopidae.*
'34. KNULL, JOSEF N., Dept. of Zoology, Ohio State Univ., Columbus 10, Ohio. (F. '43). *Cleridae, Elateridae, Buprestidae, Cerambycidae.*
'37. Knutson, Herbert C., U.S.P.H.S., 605 Volunteer Bldg., 66 Luckie St., Atlanta, Ga. *Noctuidae.*
'34. Kottke, Mrs. Esther Hendee, 4044 Warwick Ave., Chicago 41, Ill.
'17. Kraatz, Walter C., Dept. of Biology, Univ. of Akron, Akron, Ohio.
'42. Krafchick, Bernard, 578 Greene Ave., Brooklyn, N. Y.
'41. Kramer, Sol, 9 Campus Place, Brooklyn, N. Y.
'45. Krauss, Noel Louis H., Plant Quar. Inspector, Territory of Hawaii, 2437 Parker Place, Honolulu 5, Hawaii.

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'34. KROMBEIN, KARL VON VORSE, Div. of Insects, U. S. National Museum, Washington 25, D. C. (F. '44). *Aculeate Hymenoptera.*
'41. Kuitert, Louis C., Entomology Dept., Univ. of Kansas, Lawrence, Kans. *Nepidae, Gerridae.*
'36. Kulash, Walter M., Dept. of Zoology & Entomology, North Carolina State College, Raleigh, N. C. *Collembola.*

L

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'46. Laidlaw, Harry H., F. S. C. Laboratory, 281 South St., Jamaica Plain 30, Mass.
'28. Lamiman, J. F., 2244 Summer St., Berkeley 7, Calif. *Acarina.*
'30. LANDIS, B. J., P. O. Box 218, Union Gap, Wash. (F. '40). *Biological Control.*
'42. Lane, John, Instituto de Higiene de Sao Paulo, Caixa Postal 99B, Sao Paulo, Brazil.
'40. Lange, W. Harry, Jr., Div. of Entomology, Univ. of California, Davis, Calif. *Lepidoptera.*
'25. Langford, George S., Dept. of Entomology, Univ. of Maryland, College Park, Md. *Economic Entomology.*
'17. Langston, James M., State College, Miss. *Phyllophaga.*
'37. LaRivers, Ira, Box 1493, Reno, Nev. *Odonata, Psychodidae.*
'14. Larrimer, W. H., U. S. D. A., Forest Service, Washington, D. C. *Cicadellidae.*
'38. Larson, N. P., Box 674, Hulmeville, Pa. *Physiology.*
'37. Lassmann, G. W., Independencia No. 3, Jalapa, Vera Cruz, Mexico. *Culicidae.*
'13. LATHROP, F. H., Agric. Exper. Sta., Orono, Me. (F. '41). *Cicadellidae.*
'40. Latta, Randall, Bur. of Ent. & Plant Quar., Washington, D. C. *Toxicology.*
'23. Lauderdale, J. L. E., P. O. Box 2006, Phoenix, Ariz.
'17. LAWSON, PAUL B., 2215 Vermont St., Lawrence, Kans. (F. '31). *Cicadellidae.*
'39. Leech, H. B., P. O. Box 308, Vernon, British Columbia, Canada. *Coleoptera.*
'12. LEIBY, R. W., Comstock Hall, Cornell Univ., Ithaca, N. Y. (F. '40). *Embryology.*
'38. Leonard, Justin W., Institute for Fish Research, University Museums Annex, Ann Arbor, Mich. *Aquatic Insects.*
'11. LEONARD MORTIMER D., 2480 Sixteenth St. N. W., Washington, D. C. (F. '46). *Aphididae.*
'34. LeVeque, Norma, 2135 Fourth St., Boulder, Colo. *Apoidea.*
'45. Lewis, Mrs. Sue Sparks, 224 East High St., Lexington, Ky. *Ants.*
'33. Lilly, John H., King Hall, Univ. of Wisconsin, Madison 6, Wis. *Coleophoridae.*
'34. Lindgren, David L., Univ. of California, Citrus Exper. Sta., Riverside, Calif. *Toxicology.*
'39. Lindquist, Arthur W., Box 3391, Orlando, Fla. *Chironomidae.*
'46. Lindsay, Dale R., P. O. Box 932, Pharr, Texas. *Medical Entomology.*
'17. LINDSEY, A. W., Box 612, Granville, Ohio. (F. '40). *Hesperioidea.*
'33. *LINSLEY, E. GORTON, 112 Agricultural Hall, Univ. of California, Berkeley, Calif. (F. '41). *Cerambycidae, Coleoptera.*
'25. LIST, GEORGE M., Agricultural College, Fort Collins, Colo. (F. '32). *Cimicidae.*
'30. Livingston, E. M., 4425 Bienville Ave., New Orleans, La.
'31. Lloyd, Llewellyn, University of Leeds, London, England.
'19. Lobdell, Mrs. Gladys H., Route 2, Brevard, N. C. *Coccidae.*
'46. Ludwig, Carl E., 19 Gates St., Manchester, N. Y.
'38. Ludwig, Daniel, Dept. of Biology, New York Univ., 181st St. and University Ave., New York 53, N. Y. *Physiology.*
'13. LUGINBILL, PHILIP, Box 495, Lafayette, Ind. (F. '41). *Phyllophaga.*
'34. Lund, Horace O., Div. of Biological Science, Univ. of Georgia, Athens, Ga. *Culicidae.*
'31. Lyle, Clay, Box 1538, State College, Miss. *Crustacea.*
'40. Lyman, F. Earle, U.S.P.H.S., P.H.S. 3472, 412 Hilldale Ave., Decatur, Ga. *Aquatic Insects, Ephemeroptera.*

M

'43. Mackenzie, G. P., 1284 Sherwood Road, San Marino 9, Calif.
'40. MacSwain, J. W., P. O. Box 175, Loving, N. M.
'20. McBride, O. C., Box 340, Honolulu 9, Hawaii. *Insecticides.*
'43. McCall, George L., 1107 Juliette Ave., Manhattan, Kans.
'29. McClure, H. Elliott, Box 292, Station A, Bakersfield, Calif. *Ecology.*
'17. McCRACKEN, ISABEL, Box 1545, Stanford Univ., Calif. (F. '39). *Apoidea.*
'10. McDaniel, Eugenia, Agric. Coll., East Lansing, Mich. *Coccidae, Orthoptera.*
'30. McGovran, E. R., Bur. of Ent. & Plant Quar., Beltsville, Md. *Toxicology.*
'11. McINDOO, N. E., 7225 Blair Road, Takoma Park, Washington 12, D. C. (F. '34). *Insect Physiology.*
'32. Madden, A. H., Bur. of Ent. & Plant Quar., Box 3391, Orlando, Fla. *Economic Entomology.*
'43. Maina, Bartholomew A., 10623 Church St., Chicago, Ill.
'40. Mangrum, James F., Box 203 F. E., Biology Dept., A. & M. College, College Station, Texas. *Acarina.*
'13. *MANN, WILLIAM M., Natural Zoological Park, Washington, D. C. (F. '37). *Formicidae.*
'23. Manter, Jerauld A., Agric. College, Storrs, Conn. *Economic Entomology.*
'22. Marcovitch, S., University Farm, Knoxville, Tenn. *Insecticides.*
'37. Markos, Basil G., 17 Mechanic St., Dover, N. H. *Toxicology.*
Ch. MARLATT, C. L., 1521 Sixteenth St. N. W., Washington, D. C. (F. '07, H. F. '41). *Coccidae.*
Ch. MARSHALL, W. S., 139 East Gilman St., Madison 3, Wis. (F. '17). *Morphology.*
'25. Martin, Charles H., Dept. of Entomology, Oregon State College, Corvallis, Ore. *Ecology.*
'43. Martin, Esmond B., 465 East 57th St., New York 22, N. Y.
'34. MARTORELL, LUIS F., Agric. Exper. Sta., P. O. Box 614, Rio Piedras, Puerto Rico. (F. '44). *Sugar Cane, Forest Insects.*
'38. Marvin, Philip H., Hartford Road, Moorestown, N. J. *Biology of Melittobia.*
'21. Mason, Arthur C., Box 150, Moorestown, N. J. *Thysanoptera.*
'30. Mason, Horatio C., 151 West Eleventh Ave., Columbus, Ohio. *Tomato Fruitworm.*
'46. Mason, William R. M., 11537 97th St., Edmonton, Alberta, Canada.
Ch. MATHESON, ROBERT, Cornell Univ., Ithaca, N. Y. (F. '28). *Ixodoidea, Culicidae.*
'34. Maxson, Asa C., P. O. Box 46, Longmont, Colo. *Aphidae.*
'36. Mead, Albert R., 1035 Franklin St., Santa Clara, Calif. *Chrysomelidae.*
'37. Medler, John T., Dept. of Ent., Univ. of Wisconsin, Madison, Wis. *Cicadellidae.*
'25. Meiners, Edwin, Room 238, 6651 Enright, St. Louis 5, Mo. *Lepidoptera.*
Ch. MELANDER, A. L., 4670 Rubidoux Drive, Riverside, Calif. (F. '14). *Diptera.*
'27. Melvin, Roy, Menard, Texas. *Physiology.*
'33. Menusan, Henry, Jr., 204 Agric. Education Bldg., State College, Pa. *Physiology, Ecology.*
'23. Merrill, G. B., Plant Board, Seagle Bldg., Gainesville, Fla. *Coccidae, Aleyrodidae.*
'12. METCALF, C. L., Dept. of Entomology, Univ. of Illinois, Urbana, Ill. (F. '20). *Syrphidae.*
'39. Metcalf, Robert L., Citrus Exper. Sta., Univ. of California, Riverside, Calif. *Insect Physiology.*
'09. METCALF, Z. P., State College Sta., Box 5215, Raleigh, N. C. (F. '34). *Homoptera*
'35. MICHELBACHER, A. E., 112 Agricultural Hall, Univ. of California, Berkeley, Calif. (F. '41). *Symphyta, Apoidea.*
'37. MICHENER, CHARLES D., American Museum of Natural History, 79th Street and Central Park West, New York, N. Y. (F. '44). *Apoidea.*
'17. MICKEL, CLARENCE E., Div. of Entomology, University Farm, St. Paul, Minn. (F. '35). *Mutillidae.*
'36. Miller, Albert, Dept. of Tropical Medicine, Tulane Univ., New Orleans 13, La. *Culicidae.*

'31. Miller, Albert C., Box 2038, Pittsburgh 30, Pa. *Membracidae.*
'42. Miller, E. Morton, Dept. of Zoology, Box 452, Univ. of Miami, Coral Gables 34, Fla.
'46. Miller, Ralph H., 581 Euclid Ave., Apt. 5, Upland, Calif.
'37. Milliron, Herbert E., 354 South Grant St., W. Lafayette, Ind.
'29. MILLS, HARLOW B., Dept. of Entomology, Montana State College, Bozeman, Mont. (F. '37). *Collembola.*
'37. Milne, Lorus J., Johnson Foundation, Univ. of Pennsylvania, Philadelphia 4, Pa. *Trichoptera.*
'25. Milum, Vern G., 104 Vivarium Bldg., Univ. of Illinois, Champaign, Ill. *Apiculture.*
'43. el Minchaoui, Ibrahim, care of Societe Generale des Sucreries et de la Raffinerie d' Egypte, P. O. B. 763, Cairo, Egypt.
'26. MINNICH, D. E., Dept. of Zoology, Univ. of Minnesota, Minneapolis, Minn. (F. '39). *Behavior.*
'38. Miroyiannis, Stanley D., Dept. of Biology, Northeastern Univ., Boston, Mass. *Histology.*
'39. Mitchell, Robert T., Patuxent Research Refuge, Bowie, Md. *Ichneumonidae & Braconidae.*
'21. MITCHELL, T. B., State College, Raleigh, N. C. (F. '37). *Apoidea, Megachile.*
'22. MONTGOMERY, B. ELWOOD, Dept. of Ent., Purdue Univ., Lafayette, Ind. (F. '31). *Odonata.*
'39. Moore, G. A., 359 Querbes Ave., Outremont, Quebec, Canada. *Hemiptera.*
'39. Moore, Warren, Bon Air, Va. *Dermestidae.*
Ch. Morgan, H. A., 2424 Kingston Pike, Knoxville, Tenn.
Ch. MORRILL, A. W., 1327 Alameda Ave., Glendale 1, Calif. (F. '39).
'12. MORRISON, HAROLD, Bur. of Ent. & Plant Quar., Washington, D. C. (F. '28). *Coccidae.*
'08. MOSHER, EDNA, R. R. No. 1, Newport, Nova Scotia, Canada. (F. '20). *Lepidoptera.*
'20. Mote, Don C., State Agric. College, Corvallis, Ore. *Economic Entomology.*
'29. MOULTON, DUDLEY, 35 Elwood St., Redwood City, Calif. (F. '31). *Thysanoptera.*
'15. MUESEBECK, C. F. W., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '34). *Braconidae, Bethylidae.*
'36. Mulrennan, J. A., State Board of Health, Box 210, Jacksonville, Fla. *Culicidae.*
'43. Muma, Martin H., Dept. of Ent., Univ. of Nebraska, Lincoln, Neb.
'27. *Munro, J. A., State College Sta., Fargo, N. D. *Orthoptera, Diptera.*
'37. Munson, Sam C., Bur. of Ent. & Plant Quar., Beltsville, Md.
'35. *Murray, William D., 4460 Rosemary Parkway, Columbus 2, Ohio. *Sphecidae.*
'28. MUSGRAVE, ANTHONY, Australian Museum, College St., Sydney, New South Wales, Australia. (F. '41). *Nycteribiidae.*
'27. Musgrave, Paul N., 1956 Underwood Ave., Huntington, W. Va. *Dryopidae.*

N

'35. Nagel, R. H., Forest Insect Investigations, Agric. Research Center, Beltsville, Md.
'46. Nakajima, Toshio, Entomological Institute, Fac. of Agr. Hokkaido, Sapporo, Imperial Univ., Japan. *Scarabaeidae.*
Ch. NEEDHAM, J. G., 6 Needham Place, Ithaca, N. Y. (F. '07, H. F. '35.) *Odonata, Ephemerida.*
'21. Neiswander, C. R., Ohio Agric. Exper. Sta., Wooster, Ohio. *Insects of Ornamentals.*
'28. Neiswander, R. B., Agric. Exper. Sta., Wooster, Ohio. *Fruit Insects.*
'39. Nesbitt, Herbert H. J., 34 Lakeside Ave., Ottawa, Ontario, Canada. *Acarina.*
Ch. Ness, Henry, 821 Kellogg Ave., Ames, Iowa. *Economic Entomology.*
'34. Nevin, F. Reese, Rider College, Trenton, N. J. *Morphology of Acarina.*
Ch. Newcomer, E. J., Box 1291, Yakima, Wash. *Fruit Insects.*
'15. Newman, George B., 246 East Hamilton Ave., State College, Pa. *Insect Histology.*
'28. Newton, Richard C., Bur. of Ent. & Plant Quar., Bozeman, Mont. *Alfalfa Weevil.*

'38. Nicholson, H. Page, U.S.P.H.S., Carter Memorial Lab., Box 547, Savannah, Ga. *Simuliidae.*
'31. Nickels, C. B., Box 209, Bur. of Ent., Brownwood, Tex. *Pecan Insects.*
'22. Noble, W. B., Bur. of Ent. & Plant Quar., Box 1857, Sacramento 9, Calif. *Hessian Fly.*
'38. Noland, Lowell E., Biology Bldg., Univ. of Wisconsin, Madison, Wis.
'17. *Notman, Howard, Circle Road, Dougan Hills, Staten Island, N. Y. *Carabidae, Staphylinidae.*
'43. Nushawg, William N., 292 Sycamore St., East Aurora, N. Y.
'37. Nye, William P., Dept. of Ent., Room 225, Utah State Agric. College, Logan, Utah. *Forest Insects.*

O

'31. O'Byrne, Harold I., R. F. D. No. 1, Box 792, Glencoe, Mo. *Ecology Lepidoptera.*
'44. Ogloblin, Alexander, 3120 Sanabria, Buenos Aires, Argentina.
'08. O'KANE, WALTER C., Durham, N. H. (F. '24).
'29. OMAN, PAUL W., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '40). *Homoptera.*
'37. O'Neill, William J., Tree Fruit Branch Exper. Sta., Box 596, Wenatchee, Wash. *Fruit Insects.*
'34. Oosthuizen, M. J., School of Agriculture, Potchefstroom, South Africa. *Stored Grain Insects.*
Ch. OSBORN, HERBERT, Ohio State Univ., Columbus, Ohio. (F. '07, H. F. '28). *Homoptera, Cicadellidae.*
'08. Osborn, H. T., 1 Highland Ave., Los Gatos, Calif. *Cicadellidae.*
Ch. OSBURN, R. C., Ohio State Univ., Columbus, Ohio. (F. '17). *Syrphidae.*
'43. Osmun, John V., Medical Branch, Headquarters 2nd Service Command, Governors Island, New York, N. Y.
'45. Owsley, William B., Kentucky Wesleyan Coll., Winchester, Ky.
'36. Owen, William Bert, Dept. of Zoology, Univ. of Wyoming, Laramie, Wyo. *Culicidae.*
'25. OZBURN, REG. H., Ontario Agric. Coll., Guelph, Ontario, Canada. (F. '43). *Insect Histology.*

P

'15. Packard, Clyde M., Bur. of Ent. & Plant Quar., Washington, D. C. *Cereal and Forage Insects.*
'18. Painter, H. R., 705 Bexley Road, West Lafayette, Ind. *Phyllophaga.*
'19. PAINTER, R. H., Dept. of Ent., Kansas State College, Manhattan, Kans. (F. '35). *Diptera, Bombyliidae.*
'39. Palm, Charles E., Dept. of Ent., Cornell Univ., Ithaca, N. Y. *Forage Crop Insects.*
'37. Palmer, Boyd B., Polytechnic Inst., San German, Puerto Rico. *Trichoptera.*
'27. PALMER, MIRIAM A., 621 South Howes St., Fort Collins, Colo. (F. '37). *Aphidae.*
'27. PARK, ORLANDO, Dept. of Zoology, Northwestern Univ., Evanston, Ill. (F. '40). *Pselaphidae.*
'39. Parker, Barbara M., Miner Laboratories, 9 South Clinton St., Chicago, Ill.
'25. PARKER, H. L., South American Parasite Lab., Blanca del Tabaré, 2950, Montevideo, Uruguay. (F. '40). *Parasitic Hymenoptera.*
'37. Parker, J. R., Bur. of Ent. & Plant Quar., Bozeman, Mont. *Orthoptera.*
'24. Parker, R. L., Dept. of Ent., Kansas State College, Manhattan, Kans. *Apiculture.*
'18. Parks, T. H., Dept. of Ent., Ohio State Univ., Columbus, Ohio.
'24. Parman, D. C., Box 509, Uvalde, Tex. *Diptera.*
'43. Parr, Thaddeus, Whitemarsh Research Lab., Box 4388, Chestnut Hill P. O., Philadelphia 18, Pa.
Ch. PARROTT, P. J., Agric. Exp. Sta., Geneva, N. Y. (F. '14).
'12. PARSHLEY, H. M., Dept. of Zoology, Smith College, Northampton, Mass. (F. '43). *Heteroptera.*
'32. Parsons, Carl T., 238 East 62nd St., New York, N. Y.

'34. Parten, Herbert H., Div. of Ent., Univ. Farm, St. Paul, Minn. *Greenhouse Insects.*
'32. Passos, Cyril F. dos, Washington Corners, Mendham, N. J. *Lepidoptera.*
Ch. *PATCH, EDITH M., P. O. Box 150, Orono, Me. (F. '14). *Aphididae.*
'35. Paullus, Harold J., Midwest Div., California Packing Corp., Rochelle, Ill.
'23. *PAYNE, NELLIE M., care of American Cyanamid Co., Boston Post Road, Stamford, Conn. (F. '40). *Physiology.*
'20. PEAIRS, L. M., Morgantown, W. Va. (F. '40).
'34. Pechuman, La Verne L., 7 Davison Road, Lockport, N. Y. *Tabanidae.*
'40. Pederson, Calvin E., Dept. of Ent., Michigan State College, East Lansing, Mich.
'37. Pelton, John Z., 205 First Ave., Waverly, Ohio. *Aquatic Insects.*
'35. Penner, Lawrence R., Dept. of Zoology, Univ. of Connecticut, Storrs, Conn. *Araeopidae.*
'30. Pepper, Bailey B., Dept. of Ent., Agric. Exp. Station, New Brunswick, N. J. *Biological Control.*
'29. Peters, Harold T., State Teachers College, Bemidji, Minn. *Siphonaptera.*
'39. Peterson, Allan G., State Board of Health, Jackson 113, Miss. *Potato Insects.*
'11. PETERSON, ALVAH, Dept. of Ent., Ohio State Univ., Columbus, Ohio. (F. '28). *Biological Control.*
'37. Peterson, Lloyd O. T., Indian Head, Saskatchewan, Canada. *Forest Entomology.*
'40. Pettit, Lincoln C., 65 Grant St., Lockport, N. Y. *Dermestidae.*
Ch. PETTIT, R. H., Dept. of Ent., Michigan State College, East Lansing, Mich. (F. '39). *Coccidae.*
'07. PETRUNKEVITCH, ALEXANDER, Yale Univ., New Haven, Conn., (F. '37). *Arachnida.*
'43. Pfadt, Robert E., Dept. of Ent., Univ. of Wyoming, Laramie, Wyo.
'21. PHILLIPS, E. F., Cornell Univ., Ithaca, N. Y. (F. '29). *Apiculture.*
'12. Phillips, W. J., 718 Cargill Lane, Charlottesville, Va. *Harmolita.*
'37. Phillips, W. Levi, 985 South Third St., East Salt Lake City 4, Utah. *Lepidoptera.*
'44. Picard, Jean-Paul, 58-rue, St. Ambroise, Loretteville, Quebec, Canada.
Ch. PIERCE, W. DWIGHT, 1074 Browning Boulevard, Los Angeles 37, Calif. (F. '30). *Rhynchophora.*
'41. Platt, Fred R., Deputy Agric. Commissioner, Court House, Riverside, Calif. *Coccidae, Coleoptera.*
'41. Pletsch, Don, Dept. of Ent., Montana State College, Bozeman, Mont. *Psyllidae, Myrmeleonidae.*
'28. PLUMMER, C. C., Apartado Number 3, Colonia Anahuac, Mexico, D. F., Mexico. (F. '44). *Membracidae.*
'18. POOS, FRED W., Beltsville Research Center, Beltsville, Md. (F. '43).
'23. Porter, B. A., Bur. of Ent. & Plant Quar., Washington, D. C. *Fruit Insects.*
'43. Porter, John E., U. S. Quar. Sta., P. O. Drawer 1246, Miami Beach 39, Fla.
'44. Potts, Robert W. L., Room 6, Agric. Bldg., Embarcadero at Mission, San Francisco 5, Calif. *Scarabaeidae, Acraeinae.*
'26. Potts, Samuel F., 56 Hillhouse Ave., New Haven, Conn. *Toxicology, Physiology.*
'36. *Pratt, Harry D., U. S. Public Health Service, District No. 6, San Juan, Puerto Rico. *Ichneumonidae.*
'16. Price, W. A., Univ. of Kentucky, Lexington, Ky. *Economic Entomology.*
'32. *PRITCHARD, A. EARL, Malaria Control in War Areas, P. O. Box 210, Jacksonville 1, Fla. (F. '43). *Asilidae, Itonididae.*
'40. Pritchett, John C., 22 Federal Office Bldg., Seattle 4, Wash. *Quarantine Entomology.*
'28. PROCTER, WILLIAM, Bar Harbor, Me. (F. '40). *Insects of Mt. Desert Region.*
'33. Putman, W. L., Dominion Ent. Lab., Vineland Sta., Ontario, Canada. *Chrysopidae.*

Q

'36. Quarterman, Kenneth D., P. O. Box 789, Panama City, Fla. *Cimicidae.*

R

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'23. READIO, PHILIP A., Dept. of Ent., Cornell Univ., Ithaca, N. Y. (F. '37). ***Reduviidae.***
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'23. Reed, W. D., Office of the Chief Engineer, New War Department Bldg., Room 5020, Washington, D. C. *Tobacco Insects.*
'30. Rees, Don M., Univ. of Utah, Salt Lake City, Utah. *Culicidae.*
'23. Reeves, Joseph A., 530 Federal Bldg., Buffalo 3, N. Y. *Chrysomelidae, Fulgoridae.*
'44. Reeves, William C., Hooper Fouudation for Medical Research, San Francisco 22, Calif.
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'45. Reichart, Charles V., Dept. of Zoology and Entomology, Ohio State Univ., Columbus 10, Ohio.
'43. Remington, Charles L., Biological Laboratory, Harvard Univ., Cambridge, Mass.
'34. Rice, Paul L., Dept. of Ent., Agric. Exp. Sta., Newark, Del. *Chalcidoidea.*
'30. RICHARDS, A. GLENN, JR., Ent. Dept., Univ. Farm, St. Paul 8, Minn. (F. '38). ***Noctuidae.***
'14. RICHARDSON, CHARLES H., Dept. of Ent., Iowa State College, Ames, Iowa. (F. '31). ***Physiology.***
'29. RICHARDSON, MAJ. H. H., U. S. D. A. Quarantine Inspection Sta., 209 River St., Hoboken, N. J. (F. '41). ***Physiology.***
'28. Richmond, Edward A., 31 Rosemont Ave., Frederick, Md. *Hydrophilidae.*
'46. Ricker, William E., Dept. of Zoology, Indiana Univ., Bloomington, Ind. *Plecoptera.*
'39. Riedel, F. A., 2894 Dexter St., Denver 7, Colo.
'43. Rieder, Robert E., Extension Ent. & Plant Pathologist, Oregon State College, Corvallis, Ore.
'39. Riegel, Garland T., Dept. of Entomology, Univ. of Illinois, Urbana, Ill. *Braconidae.*
'22. Ries, Donald T., Box 6, Utica, Ill. *Cephidae, Siricidae.*
'40. Riherd, Paul T., Box 1936, Nogales, Ariz. *Culicidae.*
'29. Riley, Merrill K., Box 38, Kaneohe, T. H. *Coccidae.*
Ch. RILEY, WILLIAM A., Dept. of Zoology, Univ. of Minnesota, Minneapolis, Minn. (F. '14). ***Parasitology.***
'39. Rings, Roy W., 1158 Oakland Ave., Columbus, Ohio. *Cerambycidae.*
'33. RITCHER, PAUL O., Agric. Exp. Sta., Lexington, Ky. (F. '44). ***Phyllophaga.***
'36. Ritchie, C. L., c/o Richard Saxon, Box 340, Honolulu 9, Hawaii.
'25. RIVNAY, EZEKIEL, Agric. Exp. Sta., Rehoboth, Palestine.
'39. Roark, R. C., Bur. of Ent. & Plant Quar., Beltsville, Md. *Insecticides.*
'40. Roberts, H. Radclyffe, Villa Nova, Pa. *Acrididae.*
'31. Roberts, J. Harvey, Box 8729, University, La. *Trichoptera.*
'43. Roberts, Reed S., 346 West First North, Logan, Utah.
'45. Robinson, John H., 715 Moret Plaza, Grand Prairie, Tex.
'15. Robinson, J. M., Box 671, Auburn, Ala.
'45. Robinson, Paul Francis, 21 Fenwood Road, Boston 15, Mass.
'26. ROBINSON, WILLIAM, Burnt Mills Hills, Silver Spring, Md. (F. '39). ***Physiology.***
'41. Rockstein, Morris, Div. of Ent., Univ. of Minnesota, University Farm, St. Paul, Minn.
'13. Rockwood, L. P., Forest Grove, Ore. *Noctuidae, Orthoptera.*
'31. Rodeck, Hugo G., Univ. of Colorado Museum, Boulder, Colo. *Nomada.*
'44. Rodock, Roy Edgar, Lewiston State Normal School, Lewiston, Idaho.
'15. ROGERS, J. SPEED, 310 College Court, Gainesville, Fla. (F. '43). ***Tipulidae.***

'41. *Rogoff, William M., 62 Hobson St., East Haven, Conn.
'27. ROHWER, S. A., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '29). *Hymenoptera.*
'25. Rosewall, O. W., Box 8729, Dept. of Ent., Louisiana State Univ., Baton Rouge, La. *Coleoptera, Pentatomidae.*
'39. Ross, Edward S., Dept. of Ent., California Academy of Sciences, Golden Gate Park, San Francisco, Calif. *Histeridae, Embioptera.*
'31. Ross, HERBERT H., Natural History Survey, Urbana, Ill. (F. '37). *Sawflies, Caddis Flies.*
'12. Ross, William A., Vineland Sta., Ontario, Canada. *Aphidae.*
'40. Roth, Louis M., Dept. of Zoology, Ohio State Univ., Columbus 10, Ohio. *Diptera, Culicidae.*
'36. ROZEBOOM, LLOYD EUGENE, School of Hygiene & Public Health, 615 North Wolf St., Baltimore, Md. (F. '46). *Culicidae.*
'14. Ruckes, Herbert, 167–11 33rd Ave., Flushing, New York, N. Y. *Pentatomidae.*
'39. Rude, Clifford S., Box 96, Menard, Tex. *Ixodidae.*
Ch. RUGGLES, A. G., University Farm, St. Paul, Minn. (F. '35).
'46. Russell, Louise M., Bur. of Ent. & Plant Quar., Washington, D. C.
'42. Ryan, George S., care of C. H. Elliott, Angola, Ind.

S

'33. *SABROSKY, CURTIS W., Div. of Insects, U. S. National Museum, Washington, D. C. (F. '41). *Chloropidae.*
'41. Sailer, Reece I., Div. of Insects, U. S. National Museum, Washington, D. C. *Hemiptera.*
'38. Sailsbury, Murl B., 824 Gaffield Place, Evanston, Ill. *Chrysomelid Larvae.*
'46. Sakagami, Shoichi, Entomological Institute, Hokkaido, Imperial Univ., Sapporo, Hokkaido, Japan.
'29. Sakimura, Kay, Pineapple Research Institute, Box 3166, Honolulu 2, Hawaii. *Thysanoptera.*
'46. Sallee, Roy M., 131 North Normal St., Macomb, Ill.
'37. Sampson, William W., 156 South Fourteenth St., Richmond, Calif. *Aphididae, Aleurodidae.*
'31. SANDERSON, MILTON W., Natural History Survey, Urbana, Ill. (F. '43). *Coleoptera.*
'07. SATTERTHWAIT, A. F., 806 Ohio St., Urbana, Ill. (F. '30). *Calendra.*
'46. Sawamoto, Takahisa, Hokkaido Forest Exp. Sta., Toyohira 5 jo 13 chome, Sapporo, Japan. *Scolytidae, Scolytoplatopidae, Platypodidae.*
'29. Scaramuzza, L. C., Central Mercedes, Prov. of Matanzas, Cuba. *Sugar Cane Insects.*
'30. Schlosberg, Morris, P. O. Box 606, West Lafayette, Ind. *Lepidoptera.*
'29. Schmidt, Carl T., Box 3166, Honolulu, Hawaii. *Ecology.*
'33. Schmidt, Helen D. O'Neil, Box 3166, Honolulu, Hawaii. *Trichoptera.*
'20. Schmieder, Rudolf G., Zoology Lab., Univ. of Pennsylvania, Philadelphia, Pa.
'32. SCHMITT, JOHN B., Dept. of Ent., N. J. Agric. Exp. Sta., New Brunswick, N. J. (F. '43). *Morphology.*
'34. Schmitt, T. J., Jr., Apt. 16, 1086 Corona St., Denver 3, Colo. *Scolytidae.*
'44. Schnitzer, Robert C.
Ch. SCHOENE, W. J., Agric. Exp. Sta., Blacksburg, V. (F. '44).
'36. Schoof, Herbert F., 302 Horne St., Raleigh, N. C. *Chrysomelidae.*
'29. Schroeder, H. O., 5601 Patrick Henry Drive, Baltimore, Md. *Ixodoidea, Argasidae.*
'37. Schroeder, Philip M., 2521 Irving Ave. South, Minneapolis, Minn. *Forest Insects.*
'40. Schuh, Joe, Box 101, Gresham, Ore. *Odonata.*
'26. SCHWARDT, H. H., Dept. of Ent., Cornell Univ., Ithaca, N. Y. (F. '35). *Tabanidae.*
'26. SCHWARZ, HERBERT F., American Museum of Natural History, 77th St. & Central Park West, New York, N. Y. (F. '37). *Meliponidae.*
'28. Scotland, Minnie B., 42 Continental Ave., Cohoes, N. Y. *Lemna Insects.*

'25. SCULLEN, H. A., Dept. of Ent., Oregon State College, Corvallis, Ore. (F. '40). *Cerceridae.*
'46. Seabrook, Edwin L., County Courthouse Annex, West Palm Beach, Fla.
'23. Seamans, H. L., 616 Confederation Bldg., Ottawa, Ontario, Canada. *Muscoidea.*
'41. Sears, Jack W., B. L. 319, Univ. of Texas, Austin 21, Tex.
'36. Seevers, Charles, Roosevelt College of Chicago, 231 South Wells St., Chicago 4, Ill. *Termitophiles.*
'38. Semans, Frank M., North Jackson, Ohio. *Insect Control.*
'08. SEVERIN, H. C., South Dakota State College, Brookings, S. D. (F. '39). *Orthoptera, Homoptera, Heteroptera.*
'07. SHAFER, GEORGE D., 321 Melville Ave., Palo Alto, Calif. (F. '41). *Physiology.*
'46. Sharp, S. S., Dept. of Zoology & Entomology, Iowa State College, Ames, Iowa. *Toxicology.*
'35. Shaw, Frank R., Fernald Hall, Massachusetts State College, Amherst, Mass. *Mycetophilidae.*
'29. Shaw, John G., Laboratorio Entomologico, Apt. Number 3, Colonia Anhuac, D. F., Mexico.
Ch. SHELFORD, V. E., Vivarium Bldg., Wright and Healy Sts., Champaign, Ill. (F. '20). *Ecology.*
'43. Shenefelt, Roy D., Zoology Dept., Washington State College, Pullman, Wash.
'22. SHEPARD, HAROLD H., Insecticide Testing Laboratory, Production & Marketing Adm., Beltsville, Md. (F. '39). *Hesperiidae.*
'17. Sherman, Franklin, Div. of Ent., Clemson College, S. C. *Acrididae, Cerambycidae, Cicindelidae.*
'11. SHERMAN, JOHN D., JR., 312 Primrose Ave., Mt. Vernon, N. Y. (F. '39). *Dytiscidae.*
'34. Shields, S. E., Grand River, Iowa. *Culicidae.*
'35. *Shockley, Wilfred, 1180 Sherman St., Denver 3, Colo. *Cerambycidae, Decticinae.*
'28. Shropshire, Leslie H., care of Fairmont Packing Co., Fairmont, Minn. *Economic Entomology.*
Ch. SHULL, A. FRANKLIN, 431 Highland Road, Ann Arbor, Mich. (F. '39). *Aphididae.*
'15. SILVESTRI, FILIPPO, Scuola Superiore d'Agricoltura, Portici, Italy. (F. '20). *Thysanura, Protura, Termites, Myriapoda.*
'32. Silvey, J. K. Gwynn, Dept. of Biology, North Texas State Teacher's College, Denton, Tex. *Coleoptera.*
'42. Simmonds, Frederick J., Imperial Parasite Service, Belleville, Ontario, Canada.
'29. Simmons, Perez, 712 Elizabeth St., Fresno 3, Calif. *Dried Fruit Insects.*
'39. Simonds, William E., Gridmoor Ojai, Calif. *Elateridae.*
'30. *Simpson, Geddes W., Holmes Hall, Orono, Me. *Insects and Plant Diseases.*
'38. Singleton, J. M., 209 River St., Hoboken, N. J. *Quarantines.*
'43. Slifer, Eleanor H., Dept. of Zoology, State Univ. of Iowa, Iowa City, Iowa.
'32. Smith, Carroll N., P. O. Box 78, Savannah, Ga. *Ixodidae.*
'32. Smith, Charles E., Agric. Exp. Sta., University Branch, Baton Rouge, La. *Truck Crop Insects.*
'35. SMITH, CLYDE F., Dept. of Ent., Univ. of North Carolina, Raleigh, N. C. (F. '46). *Aphididae.*
'27. SMITH, FLOYD F., Research Center, Beltsville, Md. (F. '43).
'35. Smith, Howard W., Nesmith Hall, Durham, N. H.
'37. Smith, Marion E., Fernald Hall, Massachusetts State College, Amherst, Mass. *Arctiidae.*
'19. SMITH, MARION R., Room 377, U. S. National Museum, Washington, D. C. (F. '38). *Formicidae.*
'42. Smith, Ray F., 112 Agriculture Hall, Univ. of California, Berkeley, Calif. *Diabrotica.*
'14. SMITH, ROGER C., Dept. of Ent., Kansas State College, Manhattan, Kans. (F. '31). *Neuroptera.*
'38. Smith, Septima C., Box 1446, University, Ala. *Odonata.*
'44. Smith, William Ward, U.S.P.H.S., Malaria Control in War Areas, Jackson 113, Miss.

'18. Snapp, Oliver I., Box 527, Fort Valley, Ga. *Rhynchophora.*
'39. Snipes, B. Thomas, Office of State Entomologist, State Dept. of Agric., Powell, Wyo. *Siphonaptera.*
'24. SNODGRASS, R. E., 3706 Thirteenth St., N. W., Washington, D. C. (F. '27). *Morphology.*
'45. Snow, Willis E., Dept. of Ent., Univ. of Illinois, Urbana, Ill.
'44. Snyder, Everett G., 1739 Gerrard Ave., Columbus 8, Ohio.
'36. Snyder, Fred M., 721 Oak Ave., Orlando, Fla. *Muscoidea.*
'38. Sommerman, Kathryn M., Box 53, Mt. Carmel, Conn. *Corrodentia.*
'26. Sorenson, Charles J,. Agric. Exp. Sta., Logan, Utah. *Miridae.*
'43. Sparks, Sue, (Mrs. W. M. Lewis), 224 East High St., Lexington, Ky.
'14. *Spencer, G. J., Univ. of British Columbia, Vancouver, British Columbia, Canada. *Trypetidae.*
'19. SPENCER, HERBERT, Box112, Fort Pierce, Fla. (F. '37). *Hymenoptera.*
Ch. SPOONER, CHARLES S., 1436 Seventh St., Charleston, Ill. (F. '43). *Fulgoridae.*
'39. Stafford, Eugene M., Univ. of California, Davis, Calif. *Vegetable Insects.*
'10. STAFFORD, E. W., State College, Miss. (F. '43). *Mallophaga.*
'38. Stains, George S., Dept. of Ent., Utah State College, Logan, Utah. *Conopidae, Simuliidae.*
'30. Stanford, J. S., Agric. College, Logan, Utah. *Siphonaptera.*
'30. Stanley, W. W., Agric. Exp. Sta., Knoxville, Tenn. *Phalaenidae.*
'35. Stehr, William C., Dept. of Biology, Ohio University, Athens, Ohio. *Coccinellidae, Carabidae.*
'27. Steiner, L. F., 1237 Washington Ave., Vincennes, Ind. *Fruit Insects.*
'46. Steinhaus, Edward A., Insect Pathology Lab., Univ. of California, Berkeley 4, Calif.
'29. Steinweden, John B., Bur. of Nursery Service, State Dept. of Agric., Sacramento, Calif. *Coccidae, Thysanoptera.*
'31. STEWART, M. A., Div. of Ent., 112 Agric. Hall, Univ. of California, Berkeley, Calif. (F. '41). *Siphonaptera.*
'15. Stiles, Charles F., Box 29, Stillwater, Okla.
'38. Stitt, Loyd L., 321 Seventh Ave., N. W., Puyallup, Wash. *Miridae.*
'27. STONE, ALAN, Bur. of Ent. & Plant Quar., Washington 25, D. C. (F. '40). *Simuliidae, Tabanidae.*
'36. Stone, Philip C., 105 Whitten Hall, Univ. of Missouri, Columbia, Mo. *Ixodidae.*
'28. Stone, William E., Laboratorio Entomologica, Apartado Number 3, Colonia Anahuac, D. F., Mexico.
'42. Strandtmann, R. W., Dept. of Preventive Medicine, Medical Branch, Univ. of Texas, Galveston, Tex. *Sphecidae.*
'12. Strickland, E. H., Main Library, Univ. of Alberta, Edmonton, Alberta, Canada. *Elateridae.*
'25. Strohecker, H. F., New Mexico Highlands Univ., Las Vegas, N. M.
'34. Strom, Lawrence G., 604 A. South 28th St., Milwaukee, Wis. *Aphiidae.*
'31. Summerour, A. R., Box 173, Lucedale, Miss.
'23. SWEETMAN, HARVEY L., State College, Amherst, Mass. (F. '43). *Ecology.*
'20. SWEZEY, OTTO H., 2044 Lanihuli Drive, Honolulu 5, Hawaii. (F. '30). *Delphacidae.*
'44. Swift, Hewson H., 85 Bedford St., New York, N. Y. *Araneida, Ichneumonidae.*

T

'46. Takahasi, Hirosi, Ent. Institute, Hokkaido Imperial Univ., Sapporo, Japan. *Simuliidae and Tabanidae.*
'37. Talbot, Mary, Lindenwood College, St. Charles, Mo. *Formicidae.*
'36. Tanner, M. C., 2902 Jackson Ave., Ogden, Utah. *Plecoptera.*
'27. Tanner, Vasco M., Brigham Young Univ., Provo, Utah. *Tenebrionidae, Carabidae.*
'40. Tarshis, Irvin, 854 Steele St., Denver 6, Colo.
'31. Tate, Dr. H. D., Naugatuck Chemical Division, U. S. Rubber Co., Naugatuck, Conn. *Ixodidae.*

'36. *Tauber, Oscar E., Dept. of Zoology, Iowa State College, Ames, Iowa. *Physiology.*
'22. Taylor, Leland H., Dept. of Botany, West Virginia University, Morgantown, W. Va. *Bees, Wasps.*
'34. *Telford, Horace S., Research Laboratories, Dr. Hess & Clark, Inc., Ashland, Ohio. *Syrphidae.*
'40. Thatcher, Theodore O., care of J. Karl Wood, River Heights, Logan, Utah. *Scolytidae, Buprestidae, Cerambycidae.*
'21. Thomas, Charles A., State College Lab., Kenneth Square, Chester County, Pa. *Elateridae, Scarabaeidae.*
'32. Thomas, Edward S., Ohio State Museum, Ohio State Univ., Columbus 10, Ohio. *Orthoptera.*
'38. Thomas, Henry D., North Park College, Foster & Kedzie, Chicago 25, Ill.
'15. Thomas, F. L., Agric. Exp. Sta., College Station, Tex. *Cotton Insects.*
'39. Thompson, W. L., Box 1074, Lake Alfred, Fla. *Citrus Insects.*
'10. THOMPSON, W. R., 228 Dundas St., Belleville, Ontario, Canada. (F. '27). *Tachinidae.*
'22. Tietz, Harrison M., Dept. of Zoology, Pennsylvania State College, State College, Pa. *Noctuidae.*
'11. TIMBERLAKE, P. H., Citrus Exp. Sta., Riverside, Calif. (F. '38). *Encyrtidae.*
'23. Tissot, A. N., Agric. Exp. Sta., Gainesville, Fla. *Aphididae.*
'26. Todd, F. E., care of Bee Culture, Beltsville, Md. *Apiculture.*
'33. *TOWNES, HENRY K., JR., 24 Lincoln Ave., Takoma Park, Md. (F. '43). *Ichneumonidae, Chironomus.*
'28. Townsend, Lee H., Dept. of Ent., Univ. of Kentucky, Lexington, Ky. *Neuroptera.*
'36. Trager, William, Rockefeller Institute, Princeton, N. J. *Insect Nutrition.*
'39. Traub, Robert, 1207 North Pitt St., Alexandria, Va. *Siphonaptera.*
'30. TRAVER (MISS) JAY R., Fernald Hall, Massachusetts State College, Amherst, Mass. (F. '35). *Ephemeridae.*
'30. Travis, Bernard V., Box 3391, Orlando, Fla. *Culicidae.*
'39. Trembley, Helen L., National Institute of Health, Bethesda, Md.
'34. Trippel, A. W., Indiana Dept. of Conservation, Box 408, Auburn, Ind. *Chrysomelidae.*
'08. Turner, William F., 308 Woodward Ave., Chattanooga 4, Tenn.
'29. *TUTHILL, L. D., Dept. of Entomology, Iowa State College, Ames, Iowa. (F. '43). *Psyllidae, Fulgoridae.*

U

'32. USINGER, ROBERT L., Div. of Ent., Univ. of California, Berkeley, Calif. (F. '41). *Heteroptera, except Corixidae.*

V

'22. Vance, Arlo M., Box 606, West Lafayette, Ind. *Ecology.*
Ch. Van Dine, D. L., 805 Crescent Drive, Alexandria, Va. *Fruit Insects.*
Ch. VAN DYKE, E. C., Dept. of Ent., California Academy of Science, Golden Gate Park, San Francisco, Calif. (F. '17). *Coleoptera.*
'39. Vazquez, Leonila (Miss), Instituto de Biologia, Casa del Lago, Chapultepec D. F., Mexico. *Psychidae.*
'42. Velasco, Vincente, Carrera 9a–No. 4-68, Cali, Colombia, South America.
'43. Vernard, Carl E., Dept. of Zoology, Ohio State Univ., Columbus 10, Ohio.
'40. Vogt, George B., care of Dysentery Control Project, Pharr, Tex. *Coleoptera, Hemiptera.*

W

'15. WADE, J. S., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '37). *Coleoptera.*
'21. WADLEY, F. M., 3215 N. Albemarle, Arlington, Va. (F. '39). *Aphididae.*
'18. Wainwright, C. J., 50 Christchurch Road, Bournemouth, England. *Tachinidae.*

'22. Walkden, Herbert H., Bur. of Ent. & Plant Quar., 201 Post Office Bldg., Hutchinson, Kans. *Noctuidae.*
'10. WALKER, E. M., Dept. of Biology, Univ. of Toronto, Ontario, Canada. (F. '14). *Odonata, Orthoptera.*
'30. Walker, Harry G., Truck Exp. Sta., P. O. Box 276, Norfolk, Va. *Economic Entomology.*
'38. Wallace, George E., Dept. of Ent., Carnegie Museum, Pittsburgh, Pa. *Chalcididae.*
'23. Wallace, Hugh E., 210 Santa Rita, Modesto, Calif.
'32. WALLEY, G. STUART, Entomological Branch, Ottawa, Ontario, Canada. (F. '41). *Hymenoptera, Hemiptera.*
'37. Walter, E. V., Box 495, Lafayette, Ind. *Economic Entomology.*
'17. WALTON, WILLIAM R., 4323 Madison St., Hyattsville, Md. (F. '37).
'36. Wardle, Robert A., Dept. of Zoology, Univ. of Manitoba, Winnipeg, Manitoba, Canada.
'46. Watanabe, Chihisa, Ent. Institute, Hokkaido Imperial Univ., Sapporo, Hokkaido, Japan. *Parasitic Hymenoptera.*
'13. WATSON, J. R., Agric. Exp. Sta., Univ. of Florida, Gainesville, Fla. (F. '39). *Thysanoptera.*
'25. Watson, S. A., Wilmington College, Wilmington, Ohio. *Miridae, Hemiptera.*
'46. Watson, Wynnfield Y., 1c Benlamond Ave., Toronto 13, Canada. *Coleoptera.*
'16. Webber, Ray T., P. O. Box 244, Columbus 7, Ohio. *Tachinidae.*
'34. WEBER, NEAL A., Dept. of Biology, Univ. Station, Grand Forks, N. D. (F. '44). *Formicidae.*
Ch. WEBSTER, R. L., Agric. Exp. Sta., Pullman, Wash. (F. '32).
'45. Wechsler, Harry I., 2125 Holland Ave., Bronx, New York, N. Y.
Ch. WEED, CLARENCE M., 854 Andover St., Lowell, Mass. (F. '24).
'18. Wehrle, L. P., 1130 East Helen St., Tucson, Ariz. *Coccidae, Aphididae.*
'17. Weigel, C. A., Bur. of Ent. & Plant Quar., Beltsville, Md. *Greenhouse Insects.*
'39. Weinman, Carl J., 725 South Foley St., Champaign, Ill. *Insecticides.*
'45. Weisgerber, A. F., 340 North Seventh St., Newark 7, N. J.
'13. WEISS, HARRY B., 19 North Seventh Ave., New Brunswick, N. J. (F. '37). *Ecology.*
'12. WELCH, P. S., Dept. of Zoology, Univ. of Michigan, Ann Arbor, Mich. (F. '20). *Aquatic Insects.*
'07. WELD, LEWIS H., 6613 North Washington Boulevard, East Falls Church, Va. (F. '41). *Cynipidae.*
'21. Wellhouse, Walter H., Dept. of Ent., Iowa State College, Ames, Iowa.
'36. Wells, R. W., P. O. Box 208, Dallas 1, Tex. *Gasterophilus, Hypoderma.*
'44. Wene, George, Comstock Hall, Cornell Univ., Ithaca, N. Y.
'39. Wenzel, Rupert L., Chicago Natural History Museum, Roosevelt Road and Field Drive, Chicago, Ill. *Histeridae.*
'46. Werner, Floyd, 702 Pearl St., Ottawa, Ill.
'36. West, A. S., Jr., Dominion Parasite Lab., Dundas St., Belleville, Ontario Canada. *Buprestidae.*
New Brunswick, Canada. *Buprestidae.*
'45. West, Fenton T., 3401 Auburn Road, Huntington, W. Va.
'43. West, Luther S., Northern Michigan College of Education, Marquette, Mich.
'42. Westfall, Minter J., Jr., Dept. of Ent., Cornell Univ., Ithaca, N. Y.
'41. Weymarn, Michael A., 1349 South Ave., Stratford, Conn.
'39. Whall, Harry H., Mt. Hope Cemetery, Jackson Ave., Hastings-on-Hudson 6, N. Y.
'18. Whedon, A. D., 1145 Third St. North, Fargo, N. D. *Odonata.*
'22. WHEELER, GEORGE C., Univ. Sta., Grand Forks, N. D. (F. '40). *Formicidae, Eucharidae.*
'32. Whitcomb, W. D., 240 Beaver St., Massachusetts State College Exp. Sta., Waltham, Mass.
'29. Wilbur, D. A., Kansas State College, Manhattan, Kans. *Homoptera, Cicadellidae.*
'24. WILCOX, JOSEPH, 1208 East Main, Alhambra, Calif. (F. '41). *Asilidae.*
'35. Wild, William, 249 Walnut St., East Aurora, N. Y. *Microlepidoptera.*
'36. Wilkes, A., Dominion Parasite Lab., Belleville, Ontario, Canada.

'29. Will, Homer C., Juniata College, Huntington, Pa. *Tenthredinoidea.*
'38. WILLEMSE, C., Eygelshovan, Z. L., Holland. (F. '46). *Orthoptera.*
'14. WILLIAMS, C. B., Rothamsted Exp. Sta., Harpenden, Herts, England. (F. '30). *Migrations of Insects.*
'44. Williams, Genevieve, 2955 Blaine, Apt. 408, Detroit 6, Mich.
'38. Williams, J. L., Box 72, Lincoln Univ., Pa. *Lepidoptera.*
'40. Williams, Lt. Roger W., DeLamar Institute of Public Health, 600 West 168th St., New York 32, N. Y.
'44. Wilson, Clifton A., Dept. of Ent., Rutger's Univ., New Brunswick, N. J.
'23. Wilson, C. C., P. O. Box 1857, Sacramento, Calif. *Orthoptera.*
'33. Wilson, Edward H., Star Route, Gray, Me.
'25. Wilson, F. H., Dept. of Zoology, Tulane Univ., New Orleans, La. *Mallophaga.*
Ch. Wilson, Harley F., Dept. of Economic Entomology, King Hall, Univ. of Wisconsin, Madison, Wis. *Aphididae.*
'30. Wilson, John W., 5 West Washington St,. Bath, N. Y. *Economic Entomology.*
'45. Wilson, Kent Hale, 430 Ridgewood Road, Fort Worth 7, Tex.
'28. Windsor, Margaret, 220 Santa Rita, Palo Alto, Calif. *Stratiomyiidae.*
'37. Wing, Merle W., Dept. of Ent., North Carolina State College, Raleigh, N. C. *Formicidae.*
'41. *Wirth, Capt. Willis W., U. S. Coast Guard Office, Navy No. 48, care of FPO, San Francisco, Calif. *Culicidae, Reduviidae.*
Ch. *Wirtner, M., St. Vincent Archabbey, Latrobe, Pa. *Hemiptera.*
'27. Wisecup, C. B., 6936 Florence Boulevard, Omaha, Nebr. *Insecticides.*
Ch. WOGLUM, R. S., Box 5030 Metropolitan Station, Los Angeles 55, Calif. (F. '39).
'31. Woke, P. A., Carter Memorial Lab., P. O. Box 547, Savannah, Ga. *Culicidae.*
'34. Wolfenbarger, D. Otis, Route 2, Box 508, Florida Sub-Tropical Exp. Sta., Homestead, Fla. *Economic Entomology.*
'42. Wood, Stephan L., River Heights, Logan, Utah.
'14. Wood, W. B., 4620 Butterworth Place, N. W., Washington, D. C.
'37. Woodbury, Elton N., Naval Stores Dept., Hercules Powder Co., Wilmington, Del. *Insecticides.*
'25. WOODRUFF, L. C., Dept. of Ent., Univ. of Kansas, Lawrence, Kans. (F. '35). *Insect Physiology.*
'45. Worcester, Douglas John, P. O. Box 805, Puunene, Maui, Hawaiian Islands.
'22. Worthley, H. N., 683 Shadowlawn Drive, Westfield, N. Y. *Insecticides.*
'28. WRAY, DAVID L., JR., Dept. of Agri., Raleigh, N. C. (F. '43).
'41. Wright, Gilbert, Illinois State Museum, Springfield, Ill.
'39. Wright, Mike, Dept. of Biology, Tusculum College, Greeneville, Tenn. *Odonata.*

Y

'43. Yergason, Robert M., 50 Farmington Ave., Hartford, Conn. *M. D.*
'31. YEAGER, J. F., Beltsville Center, Beltsville, Md. (F. '37). *Physiology.*
'40. Yollės, Mrs. T. Knigin, 189 East 18th St., Brooklyn, N. Y.
'28. Young, Hiram C., Box 132, Florala, Ala. *Cotton Insects.*

Z

'07. ZETEK, JAMES, Drawer C, Balboa, Canal Zone. (F. '39). *Trypetidae.*
'41. *ZIMMERMAN, ELWOOD C., Bishop Museum, Honolulu 35, T. H. (F. '46).

Total Membership, 943. Fellows, 265. Honorary Fellows, 12.
Charter Members, 63. Life Members, 41.

ANNALS

OF

The Entomological Society of America

Volume XXXIX | SEPTEMBER, 1946 | No. 3

THE ENTOMOLOGICAL SOCIETY OF AMERICA

NEWS OF THE MOMENT

NEW MEMBERS

The following new members were recommended and nominated for membership in the Society since the annual meeting. They were elected to membership by mail ballot of the Executive Committee.

BEATIE, RUSSEL, Westvaco Chlorine Products Corporation, 405 Lexington Avenue, New York 17, New York.
BONHAG, PHILIP F., 134 S. Frazier Street, State College, Pennsylvania.
FOX, IRVING, School of Tropical Medicine, San Juan, Puerto Rico.
HANAN, BLAKE B., Biological Laboratory, University of Toledo, Toledo 6, Ohio.
HASBROUCK, FRANK, 303 Harker Hall, University of Illinois, Urbana, Illinois.
O'NEILL, MISS KELLIE, University of Texas, 2201A Nueces Street, Austin, 21, Texas.
SLATER, JAMES A., 1635 Maryland Drive, Urbana, Illinois.
THURMAN, DEED C., JR., 605 Volunteer Building, Atlanta, Georgia.

SOCIETY BUSINESS AND APPOINTMENTS

FORTY-FIRST ANNUAL MEETING, 1946.—Following the action of the Executive Committee in St. Louis, the President and Secretary met with the President and Secretary of the American Association of Economic Entomologists and decided on Pittsburgh, Pennsylvania, as the best selection for the 1946 meetings, pending information regarding accommodations. Since that time we have been assured of adequate accommodations by the Hotel William Penn and the meetings are set definitely for that place, from December 9–12.

Following approval of the Executive Committee, the President and Secretary are working in conjunction with the Program Committee of the American Association of Economic Entomologists in preparing a program for a joint meeting of the two societies.

PRESIDENT MUESEBECK appointed DR. H. M. HARRIS, Department of Entomology and Zoology, Iowa State College, Ames, Iowa, as the representative of the Society to the Division of Biology and Agriculture, National Research Council. PRESIDENT MUESEBECK appointed DR. S. B. FRACKER, Agricultural Research Administration, U. S. Department of Agriculture, to represent the Society at future meetings called

by the National Research Council to give further consideration to the projected Institute of American Biologists.

H. H. Ross, *Secretary.*

REPORT OF THE REPRESENTATIVE TO THE DIVISION OF BIOLOGY AND AGRICULTURE, NATIONAL RESEARCH COUNCIL

As the representative for the Entomological Society of America to the Division of Biology and Agriculture of the National Research Council, I have the pleasure of reporting that I again attended the Executive Committee meeting and the annual meeting of this Division on April 12th and 13th, 1946.

At the annual meeting on April 13th, a number of important matters were presented to the Council, including:

1. Problems of Scientific personnel. Discussion led by M. H. Trytten, Director, Office of Scientific Personnel, N. R. C.
2. Present Status of the National Science Foundation Bill, presented by Dr. Barry Commoner.
3. The Prevention of Deterioration of Equipment in the Tropics, presented by Glenn A. Greathouse.
4. The work of the Insect Control Committee, presented by R. A. Ormsbee.
5. Discussion of the projected American Institute of Biology, led by Detlev W. Bronk.
6. A conference on the Resumption of International Scientific Relations, led by Detlev W. Bronk.
7. A report on the Activities of the Division of Biology and Agriculture.

Among the important discussions was one in relation to the National Science Foundation Bill, No. S-1850. Apparently the general feeling of all those present was that this bill will be of very substantial aid in furthering research work, especially in Universities and other organized scientific groups. Although it was pointed out that the bill barely passed the committee, and that there are two other bills in competition with this bill, it was hoped that all scientific organizations and individuals would give as much support to this bill as possible immediately. The suggestion was, too, that all organizations either write or wire their state senators and also get in touch with Senator Thomas of Utah, who was very much interested in trying to secure passage of the bill. I find out that all Land Grant Colleges and many other organizations have already done this very thing, and that most scientific organizations in St. Louis sent in very strong resolutions for the passage of bill S-1850.

A great deal of discussion was also centered around the formation of an American Institute of Biology, a matter which I understand, was also discussed quite thoroughly at the St. Louis meetings. As a result of this discussion a motion was passed requesting all of the representatives of the various societies in attendance to report to their organizations to the effect that some action should be taken to appoint representatives to discuss the formation of such an organization. In looking over the reports of the St. Louis meetings and also a letter recently received from President Clay Lyle of the American Association of Economic Entomologists, I note that representatives were appointed by the entomologists for this purpose.

In years past there was considerable opposition to the formation of the Institute which I believe was first launched under the name of Union of Biological Societies. This opposition, I think, was due more to the purposes as expressed at that time and the methods of organization rather than to the idea. If I remember correctly, one of the important items for launching this Union was the support for Biological Abstracts. All of these matters have been eliminated and the present suggested Institute is not fettered by any encumbrances whatever. Therefore, it is believed that the biologists of the country will give it much more serious consideration.

Other matters which were discussed by the Council were:

1. Admission of other organizations to membership;
2. Question of frequency of meetings;

3. Closer relationships of the Council to the various societies represented;
5. A general discussion of requirements for fellowships and scholarships in general.
5. A reorganization of the insect control committee so as to be thoroughly representative of the entomological organizations of the country;
6. Methods of aiding entomologists and entomological institutions in foreign countries, and the resumption of international scientific relations, including the organization and holding of scientific meetings.

I think this was probably the most important of all the meetings I have attended. There is every reason to believe that the relationships between the various societies and the National Research Council are to be more constructive during the coming years so that, through cooperation, a great deal of benefit will accrue to all professions participating through the guidance of the National Research Council, which also reflects somewhat the personality of the National Academy of Sciences.

This, I believe, completes my two terms of three years each as your representative and therefore, I am most happy to have a successor appointed to represent the Society for the coming year. Because of having served as a member of the Executive Committee of the National Research Council my expenses in attending the recent meetings were provided for by the Council and therefore I have no expense account to present to the Society.

I wish to take this means of sincerely thanking the various presidents of the Entomological Society of America, and you as Secretary, for the honors you have bestowed upon me in appointing me as your representative. It has offered many opportunities for educational advancement and I trust that I have been able to render some service to the Society.

Respectfully submitted,

E. O. Essig, *Representative.*

OBITUARIES

William Thompson Davis, (1862–1945), American naturalist, historian antiquarian, man of affairs, and charter member since 1908, Fellow since 1917, and Honorary Fellow since 1943 of the Entomological Society of America, was born at New Brighton (now Saint George), Staten Island, New York, on October 12th, 1862. He was the son of George B. and Elizabeth (Thompson) Davis, and of ancestry that had originally settled in Massachusetts, and of which later generations had removed to Staten Island. From childhood he was interested in natural history study, particularly of birds, plants and insects. Educated in private schools, he entered early upon a business career and for some time was with a New York mercantile establishment. In 1883, at the age of 21, he became connected with the New York Produce Exchange, with which he was associated for 26 years. At the age of 38 he was married on November 7th, 1900, to Bertha Mary Fillingham, of Livingston, Staten Island. After slightly over a year of married life, she died December 7th, 1901. In 1909, at the age of 47, he retired from active business and devoted the remaining 36 years of his life to care of his property interests and to natural history, historical and antiquarian research.

He first appears to have become really interested in insects when a lad of only 15, and that these chanced to be Cicadas was stimulated by the fact that it was during the season that the 1877 brood of these insects—the so-called "Seventeen year Locusts"—emerged from the soil. In the decades that followed, his studies of Cicadas gradually increased in range and scope until, eventually, he became one of the foremost world authorities on this fascinating group of insects. It has been said in comment on his work that out of 170 Cicadas from North America known to science, he has named and described more than 100, that the oldest fossil Cicada ever found has been named in his honor, and that his Cicada collection at the Staten Island Museum has become one of the most complete in the country.

In addition to a long series of technical writings on the Cicada, he wrote on various other insects, and also was author of a popular volume on nature study entitled "Days Afield on Staten Island," 1892, revised edition 1937. Other books written by him, of historical or antiquarian interest, are "The Church of Saint Andrew, Richmond, Staten Island," written in collaboration with his lifelong friend, Charles W. Leng, and another friend, Roydan Woodward Vosberg, and

published in 1925. Another volume by him, "Legends, Stories and Folklore of Old Staten Island, the North Shore," appeared in 1925, and still another entitled "The Conference or Billopp House," was published in 1926. Perhaps the most important single work published by Davis and Leng is that entitled "Staten Island and Its People: A History 1609 to 1929," and issued in four ponderous tomes in 1930.

The friendship which existed for over sixty years between Davis and Leng, until separated by death, also is worthy of special mention. Together they worked and rambled, together they pursued their hobbies, and together they spent every possible moment. They had prominent part in forming in 1881 the Staten Island Institute of Arts and Sciences, and later in the founding and development of the Staten Island Museum, an outgrowth of the former, both of which have long and honorable records of useful service.

The memberships of W. T. Davis in scientific and other societies included the Linnean Society of New York, the Academy of Natural Science of Philadelphia, the Boston Society of Natural History, and life membership in the New York Historical Society. His very considerable activity in organizations of this kind is evidenced by the fact that he was president of the Staten Island Historical Society for 16 years from 1922 to 1938 and thereafter was president emeritus; he was president of the Brooklyn Entomological Society from 1912 to 1916 and from 1920 thereafter. He was treasurer of the New York Entomological Society for a quarter of a century from 1904 to 1929, and was its president 1929 and 1930, was member of its Executive Committee 1931–38 inclusive and was elected its Honorary President from 1940 thereafter. He was president for 11 years of the Staten Island Bird Club, and was made a Fellow of the New York Academy of Science in 1910. Further, The Park Association of the City of New York conferred upon him an Official Citation in 1941 for his interest in and assistance in development of parks and nature recreation centers on Staten Island.

He died at Staten Island Hospital, Saint George, Staten Island, on January 22nd, 1945, age 82 years, 2 months, and 10 days. The remains were interred in Moravian cemetery, New Dorp, Staten Island.

Any sketch, however brief, of William T. Davis would be incomplete that did not at least make mention of his sterling qualities of character, his gentleness, his helpfulness, his tactfulness, the charm of his personality, and—manifested over and over again in countless unrecorded acts of kindness and beneficence—the simple goodness of the man. Perhaps he will be longest remembered for his historical and antiquarian work, but American Entomology too has been left definitely enriched through the example of his life and achievements.—J. S. WADE.

PETER CHASE GRASSMAN was born at Chicago, Illinois, December 5, 1925, and was killed in action on the Saarlautern Bridge, Germany, on December 4, 1944, just one day short of his 20th birthday. He removed from Detroit, Michigan, to Phoenix, Arizona, in 1933 and graduated from the North Phoenix High School in 1943.

He was an Eagle Boy Scout with palms and served three seasons on the staff of the Scout Camp Geronimo. He became very much interested in Entomology and spent nearly two years collecting, classifying, and mounting insects, chiefly beetles and moths, but he became particularly interested in the darkling ground beetles of the family *Tenebrionidae* and he was greatly aided in his studies by Frank H. Parker, Assistant State Entomologist of Arizona, who very kindly aided in furnishing information for this notice.

In the fall of 1943 he entered the U. S. Army, having qualified for the Army Special Training Program. After completing basic training at Fort Benning, Georgia, he was assigned to the Carnegie Institute of Technology, Pittsburgh, Pa., where he was enrolled in training courses until all of the A.S.T.P. students were cancelled out in March, 1945. He was then assigned to the infantry and trained for combat intelligence and was with the 95th Division during the capture of Metz. He was awarded the Silver Star and Bronze Star Medal for heroic achievement against the enemy. He was Private First Class at the time of his death.

While he was at the Carnegie Institute he was elected a member of the Entomological Society of America in July, 1944, and was one of the youngest members of our association at the time. It was most unfortunate that he was never able to

pursue the studies he was so much interested in. A new species of beetle he collected was named for him by Parker.

He is survived by his parents and a younger brother, S. S. Grassman. His mother, Mrs. Barbara C. Grassman, gave much information used in this sketch.

—E. O. Essig.

Theodore Henry Frison, a member of the Society since 1914 and a Fellow since 1929, was born in Champaign, Illinois, January 17, 1895, and died in Champaign, December 9, 1945. Dr. Frison spent most of his life in Champaign-Urbana, where he attended Champaign High School and later the University of Illinois. During his high school years, he was a neighbor of J. W. Folsom, who tutored him in his early interest in entomology. Dr. Frison's college career was interrupted in 1918 when he entered the army, was commissioned a second lieutenant and resigned in December of the same year to resume his study of entomology at the University of Illinois. There he received his B.A. in 1918, M.A. in 1920, and Ph.D. in 1923.

In 1920, after receiving his master's degree, he was appointed Assistant State Entomologist of Wisconsin. In 1921–22, he joined the staff of the Illinois Natural History Survey as Systematic Entomologist. In 1917, the State Laboratory of Natural History and the office of State Entomologist had been merged to form the Natural History Survey, with Forbes as Chief. Upon Forbes' death in 1930, Frison became acting head of the Survey and on July 1, 1931, he was named Chief, a position he has since held.

Dr. Frison was internationally known for his studies of bumblebees, aphids, and stoneflies, and he continued his work on these groups, especially the stoneflies, until his last illness.

After he became Chief of the Natural History Survey, administrative duties claimed much of his time. Under his direction, the modern laboratories and offices of the Survey in the Natural Resources Building were planned and completed. He took an active interest in wildlife research in Illinois and was one of the principal persons responsible for the organization of the Midwest Wildlife Conference, whose first meeting was held in Urbana in 1935. He also took a very active part in the Illinois State Academy of Science and served as President of that organization in 1931–32. He has been a Director of the Central States Forestry Congress since 1933 and of the Illinois Audubon Society since 1942. He was Editor of the Journal of Economic Entomology from 1936 to 1939, and a Vice-President of the Entomological Society of America in 1936.

Among entomologists he will always be remembered for his rejuvenation of the Insect Survey of Illinois. Definite plans for this were laid in 1927 and resulted in the beginning of a series of comprehensive reports on the biology, distribution and taxonomy of various groups of Illinois insects. In this series Dr. Frison published "The Fall and Winter Stoneflies of Illinois" (1929), "The Plant Lice of Illinois" (Hottes and Frison, 1931), "The Stoneflies of Illinois" (1935), and "Studies of North American Plecoptera, with Special Reference to Illinois" (1942). Dr. Frison envisaged the insect collection not only as a museum but as a storehouse of information to support biological and economic investigations over a broad field.

Dr. Frison died after about a year's illness and is survived by his wife, Ruby Dukes Frison, a son, Theodore Henry, Jr., and a daughter, Patricia Ann.

The entomological and biological fraternity has suffered a great loss in his passing.—H. H. Ross.

Joseph R. Watson, a member of the Society since 1913 and a Fellow since 1939, was born in Berea, Ohio, on August 1, 1874, and died in Gainesville, Florida, June 6, 1946, after a brief illness. He received the B.S. degree from Baldwin College in 1897 and the M.S. from Western Reserve, in 1899. He attended several summer sessions at the University of Chicago, beginning in 1903. He served as assistant and instructor in biology at Adelbert College of Western Reserve from 1899 to 1901. The following year he was instructor of botany, physics, and chemistry at Berea College, Kentucky. From 1903 to 1905 he was head of the Department of Science at Rochester College, Indiana, and the next year he taught biology in the Manitowoc, Wisconsin, high school. In 1907 he went to the University of New Mexico, where he served as professor of biology until 1911. In 1911 he moved

to Florida as head of the Department of Entomology of the Agricultural Experiment Station, succeeding his close friend, Dr. E. W. Berger, who that year was appointed State Nursery Inspector. He continued as head of the department until his death, and in point of continuous service, was the oldest member of the Experiment Station staff.

His principal interest was in the field of applied entomology as related to Florida agriculture. He did extensive work on the biology and control of the velvet bean caterpillar and the lubberly locust. Many insect pests of citrus and vegetable crops received his attention, and he was instrumental in finding better ways of combating them. He recognized the value of biological control and initiated the introduction of parasites and predators of several crop pests. His work on the control of rootknot nematodes won for him wide acclaim. He developed methods of combating this major crop pest which are standard practices on Florida farms.

In the field of systematic entomology, he was internationally known for his work on Thysanoptera. He described some 30 new species of thrips and built up a collection of these insects, containing nearly forty thousand slides. A bibliography of his papers on this group would contain at least 50 titles. He was the author of several Experiment Station bulletins and numerous papers in scientific journals and in magazines devoted to citrus and other crops. For the past 16 years he gave an average of 30 entomological talks a year on the Florida Farm Hour program of the University radio station, and hundreds of Florida farmers thus became acquainted with him and his work.

Professor Watson was a true lover of Nature. At every opportunity he would be found at some favored spot in field or wood to observe and enjoy and collect desirable specimens. The beauty of tree, or flower, or bird, touched him deeply and he always shared with others the joy and happiness that they created in his heart. He was active to within a few days of his death and on his microscopic stage he left a slide of an undescribed thrips which he was studying, and preparing to describe. A half-finished drawing of the same insect lay on the desk by the side of the microscope. He possessed a fine sense of humor and his friendly, kindly disposition endeared him to his associates and friends who will miss him greatly.

He was a Fellow of the American Association for the Advancement of Science, a charter member and past president of the Florida Entomological Society, and also a member of several other scientific and honorary societies.

On August 26, 1902, he married Miss Elizabeth Prout, who died in 1938. He is survived by three daughters, a brother, a sister, and four grandchildren.

—A. N. TISSOT.

DR. GRACE H. GRISWOLD, since 1918 a member of the staff of the Department of Entomology, Cornell University, and an authority on household insects, died the 22nd of January, 1946. Earlier in the winter a severe attack of influenza left her in a weakened condition, but in spite of this she returned to her work in the laboratory. On the day of her death she had lunch with some friends, apparently in her usual good spirits. Her sudden demise a few hours later therefore came as a great shock to her colleagues and many friends.

Miss Griswold was the daughter of the late Dr. Joseph B. Griswold, who for many years was a prominent physician in Grand Rapids, Michigan. She was born in Taylors Falls, Minnesota, December 14, 1872, but came to Grand Rapids with her parents the following year. While a resident of that city she was an enthusiastic gardener, was one of the founders of the Kent Garden Club and its first secretary. Upon the death of her father in 1915, she entered Cornell University as a student of Landscape Architecture, graduating in the fall of 1918.

Being aware of the many insects which infest the flower garden she turned her attention to the study of entomology, entered upon graduate work in the subject and received the degree of Doctor of Philosophy from Cornell University in 1925. She was appointed a research instructor in the Department of Entomology, making a special study of insects that attack ornamental plants and of those infesting the household. The results of her various studies have been published in several bulletins of the Cornell University Experiment Station and in articles which have appeared in entomological journals.

Although officially she retired in 1941 she continued regularly to spend several hours a day in the laboratory engaged in writing up the results of her experiments and in building up a collection of aphids injurious to ornamental plants. Beginning her entomological career much later than most, by her industry and enthusiasm she established an enviable reputation as an authority in her special field. Her published papers demonstrate in their form and substance the meticulous care with which they were prepared.

She spared no effort in being helpful to the women students in whom she took a strong personal interest. A woman of strong character, with firm convictions, and outspoken, she was kindly, friendly and co-operative.

She was a fellow of the American Association for the Advancement of Science and of the Entomological Society of America; a member of the Association of Economic Entomologists, and of the honorary societies Sigma Xi and Sigma Delta Epsilon.

By her death the members of the Department of Entomology have lost a faithful colleague, her associates a devoted friend, and the University a loyal supporter.—O. A. Johannsen.

Thomas Jefferson Headlee, a charter member of the Entomological Society of America, who retired on January 1, 1944, as head of the department of entomology at Rutgers University and the New Jersey Agricultural Experiment Station, died at the Muhlenberg Hospital, Plainfield, N. J., on June 14, 1946, at the age of 69. Dr. Headlee, who was well known to many entomologists throughout the country and especially those in the east, was born February 13, 1877, at Headlee, Indiana. He was the son of Josephus Headlee, farmer, and Ruann (Mattix) Headlee. He attended the Delphi (Indiana) High School and the Indiana State Normal School. From Indiana University he received his A.B., in 1903, and his A. M., in 1904, and from Cornell University his Ph.D., in 1906. From 1895 to 1900 he taught in the township grade schools; from 1900 to 1901 he was principal of the township high school, and from 1902 to 1904 he taught biology in the city high school. In 1904 he was a summer instructor at the Indiana Biological Station. For a short time, 1906–1907, he was assistant and later associate entomologist at the New Hampshire Agricultural Experiment Station. He then went to Manhattan, Kansas, as a successor to Prof. E. A. Popenoe, and became head of the department of entomology and zoology at the Kansas State Agricultural College, where he had charge of the entomological and regulatory work from 1907 to 1912. During this period he was professor of entomology and zoology at the Kansas State Agricultural College, entomologist of the Kansas State Experiment Station and state entomologist to the Kansas Entomological Commission.

On October 1, 1912, he succeeded Dr. John B. Smith as head of the department of entomology of Rutgers College and became professor of entomology in the college, entomologist of the New Jersey Agricultural Experiment Station, and State entomologist to the New Jersey State Board of Agriculture. These positions he held until his retirement, except for that of state entomologist, which was abolished on June 30, 1933. Upon coming to New Jersey Dr. Headlee's first interest was the mosquito problem, especially the field control, and in this activity and in the fields of organization and legislation, he worked unceasingly for many years. From 1913 to 1943 he was secretary of the New Jersey Mosquito Extermination Association and from 1944 to his death, secretary emeritus. In addition, from 1935 to 1939 he was president of the American Mosquito Control Association.

Dr. Headlee's work in economic entomology covered a wide field. In addition to his teaching and to his interest in mosquito control, it embraced the study and control of insects injurious to various field and orchard crops, the study of temperature in relation to insect development, the effect of the electrostatic field on insects, the development of mosquito traps, insecticides, the promotion of industrial fellowships, etc. He also initiated in 1918 research in cranberry problems and eventually this work developed into a separate department. He also carried on a study of the biology of sewage disposal and this, too, developed into a separate department in 1926.

When the Japanese beetle was discovered in New Jersey in 1916 and the gypsy moth in 1920, Dr. Headlee took an active part in planning work against these pests. He helped to organize the Northeastern Entomologists, which held their first

meeting in Philadelphia in July, 1920, and this organization later became the Eastern Branch of the American Association of Economic Entomologists.

Dr. Headlee kept in close touch with various organized interests in New Jersey and for many years attended nearly all meetings of entomologists, held in the east. In addition he participated in many field trips. Because of this, he was known personally to many workers in the field of entomology. In fact, he cultivated human relationships extensively, knowing that without such support, many control programs would fail. In addition to his research activities he was interested in quarantine and regulatory work for the control of bee disease and nursery and agricultural pests, both in New Jersey and the nation at large, and in many instances took an active part in formulating policies. From 1925 to 1936 he was president of the Eastern Plant Board and for a time served as vice-president of the National Plant Board. In 1935 he was awarded the Rutgers College bronze medal and in January, 1944, he was selected by the New Jersey State Board of Agriculture for their annual Citation for Distinguished Service to New Jersey agriculture. In 1929 he was elected president of the American Association of Economic Entomologists and served this organization capably in various capacities for several years.

From 1924 to 1926 Dr. Headlee was a representative of the National Research Council and president of the Council in 1929. He also belonged to the Phi Beta Kappa, Sigma Xi, Alpha Zeta, the Entomological Society of America (charter member), the American Association of Economic Entomologists, and its Eastern Branch, and was a fellow of the American Association for the Advancement of Science, and an honorary member of the Eastern Nurserymen's Association, the New Jersey State Horticulture Society, official entomologist of the Society of American Florists and Ornamental Horticulturists (1916), and for many years, a member of the committee on research of the American Cranberry Growers' Association. Following his retirement in 1944, the Thomas S. Headlee Fellowship Fund was started by friends and associates.

On October 11, 1903, Dr. Headlee married Blanche Ives, of Delphi, Indiana. Four daughters were born, Mary Ruanna, Miriam Esther, Ruth Margaret, and Josephine (dec.). At his death Dr. Headlee was survived by his wife, Mrs. Blanche Ives Headlee, and three daughters, Mrs. Floyd Markham of New York, Mrs. Carl Stover and Miss Ruth Headlee of Dayton, N. J., where Dr. Headlee lived and operated a 45-acre apple orchard. Funeral services for Dr. Headlee were held in Kirkpatrick Chapel of Rutgers University on June 17, 1946. Dr. Headlee was the author of approximately 300 papers, bulletins, reports, etc., on various aspects of his work. His last publication was a book on "The Mosquitoes of New Jersey and Their Control," published in 1945 by the Rutgers University Press. His death brought to a close an active, varied and successful career in economic entomology.—H. B. WEISS.

THE COMMITTEE ON BIOGRAPHIES.

H. B. WEISS,
J S. WADE,
E. O. ESSIG, *Chairman.*

THE TAXONOMY AND BIONOMICS OF SOME PANAMANIAN TROMBIDIID MITES (Acarina)[1]

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New York City

The principal purpose of this paper is to present information concerning the life histories of some species of mites from Panama. Incidentally, several species are described as new.[3] The need for knowledge of life histories, particularly for correlations of larvae and adults, is great in the Trombidiidae, because the great majority of the species and even of the genera are known from larvae only or adults only. Thus there are two nearly separate classifications, one for adults, the other for larvae.

CLASSIFICATION

The family Trombidiidae was divided by Thor (1935) into ten subfamilies, and this classification has been followed by Womersley (1937) and others. The species discussed in this paper all fall in the subfamilies Allothrombidiinae and Microtrombidiinae. The Trombiculinae are considered only in a comparative way in the section on life history, the detailed information concerning them having been presented in previous papers. Incidentally, it does not seem justifiable to recognize the latter group as a separate family as has recently been done (Ewing, 1944), especially when the other nine subfamilies are not also raised to family rank. It is far more logical to expand and enrich the classification by the use of subfamily and tribal names than by elevating each slightly distinct group to the family status.

Numerous genera have been described in the Microtrombidiinae, many of them based primarily on differences in the structure of the body hairs. Such differences are exceedingly striking, and in some instances doubtless offer good generic characters. However, some of the "genera" are merely unnatural assemblages of species. Obviously related species sometimes have very different body hairs and fall into different "genera." Thus, the species *pistiae* and *maculatum* described in this paper are clearly related, as shown by such characters as the

[1]The cost of publishing this article is paid by the Gorgas Memorial Laboratory.—EDITOR.

[2]Acknowledgment is made to the Gorgas Memorial Laboratory, Panama City, R. P., and especially to its director, Dr. Herbert C. Clark, for excellent facilities provided for this work.

The work described in this paper was done, in part, under a contract (recommended by the Committee on Medical Research) between the Office of Scientific Research and Development and the Gorgas Memorial Laboratory.

[3]Holotypes and allotypes of all new species will be placed in the collection of the American Museum of Natural History. Paratypes of each species will be deposited in the U. S. National Museum and the Museum of Comparative Zoology.

bidentate chelicerae of the larvae, the loss of one of the claws of the posterior legs of the larvae, the structure of the pedipalps and their claws in the larvae, the shape of the crista and associated structures in the adults, the presence of two accessory claws on the pedipalps of the adults, etc. Yet because the body hairs differ, these two species would fall in different genera in recent classifications. For the present, I have followed the example of Boshell and Kerr (1942) and described such species in *Microtrombidium*. At some later date, when more larvae and adults have been correlated, it will doubtless be possible to define natural genera.

There is a wide range of variation in some of the characters which have commonly been considered of value in distinguishing species. This is particularly true in species which grow and molt as adults. Thus in *Manriquia bequaerti* the number of setae in the basal comb of the pedipalpal tibia ranges from eight to thirty, and in *M. panamensis*, from four to twenty-one.

LIFE HISTORY

In order to clarify the use of the terms here employed to designate the various stages in the life cycle of these mites, a summary of the life history is here presented. The opportunity is taken to point out certain differences between the subfamilies which apply to all the species investigated in this study. When the stages of the life cycle are known for a greater number of genera and species, some of these differences may be shown to be subfamily characters.

The *eggs* are spherical, smooth or feebly roughened, laid in groups or masses in the Microtrombidiinae and Allothrombidiinae, and occasionally in the Trombiculinae, although they are more often laid singly in the latter subfamily. In one species (*Microtrombidium maculatum*) the eggs are laid in a mass in a matrix of a translucent gelatinous substance. Apparently there is a correlation between the size of the mite and the manner in which the eggs are laid. Thus it is the small species which lay eggs singly, middle sized species in small clusters, and large species in large masses. There may be several hundred eggs in the masses of *Allothrombium metae*, a large mite, reaching a length of 3.5 mm. The duration of the egg stage ranges from as little as four days (in *Microtrombidium pistiae*) to over two weeks (in *Manriquia bequaerti*).

Upon hatching, the chorion of the egg breaks more or less equally into two portions, and the next stage, the *deutovum*, becomes visible. The deutovum or prelarval stage is quiescent, without setae but often finely papillate, with six unsegmented immobile legs directed more or less forward and with one or occasionally two dorsal spines. In the subgenus *Megatrombicula* of the genus *Trombicula* there are several other spines on the deutovum. The posterior portion of the chorion or egg shell usually covers the posterior part of the deutovum, while the anterior portion remains over the anterior part of the deutovum, so that only the middle of the deutovum is exposed (Trombiculinae) or falls away leaving the entire anterior part of the deutovum exposed (Microtrombidiinae). The deutovum is considerably larger in size than the egg. It is possible that absorbed water accounts for this phenomenon.

Before the emergence of the larva the red pigment spots surrounding the larval eyes become visible through the integument of the deutovum. The larval appendages form within the unsegmented deutoval appendages. The coxae and trochanters of the larval legs are directed outward into three blunt lateral protuberances on each side of the deutovum; the remaining segments of the legs are directed from these protuberances downward and forward into the leg sheaths of the deutovum. For as much as three or four days, in some instances, before larval emergence, the legs of the larva may be seen moving back and forth within the leg sheaths of the deutovum.

The *larva* is an active, six-legged form, more or less sparsely setose. The larvae are parasitic, those of the Trombiculinae on vertebrates, those of the Microtrombidiinae and Allothrombidiinae on insects and spiders. After attaching themselves to their hosts by means of the chelicerae, they engorge, reaching a size varying from one and one-half (small *Eutrombicula*) to six (*Allothrombium*) times the length of the unengorged larvae. Engorgement apparently requires two or more days, larvae sometimes remaining attached to their hosts for over three weeks. The time until larvae leave the host is highly variable even among individuals of a single species. After engorgement the larvae drop from the host, walk about for a short time, and then become quiescent in a suitable hiding place. Among genera known from Panama, larvae of the Trombiculinae have a single dorsal plate while those of the other two subfamilies have two. This distinction applies in general to species from other areas of the world, but a few exceptions have been found.

After becoming quiescent, the integument of the *protonymph* or nymphochrysalis develops within that of the engorged larva. The protonymph is pupa-like and entirely quiescent, never emerging from within the larval integument, and as with other such stages, setae are absent. The protonymphal integument, however, is often exposed by breaks in the larval integument. In some species such breaks occur normally, exposing many parts of the protonymph. With the development of the protonymph, the larval appendages become dead and brittle, histolysis probably taking place within them. The appendages of the protonymph (in those groups which possess them) thus develop within the body of the larva. There are eight legs instead of six as in the larvae. The protonymphs of the three subfamilies here studied are conspicuously different from one another by the characters shown in Table I. The nymphal appendages develop within those of the protonymph in the Trombiculinae and Allothrombidiinae, and curl within the protonymphal sac (fig. 27) in the Microtrombidiinae.

The *nymph* is the first active eight legged stage. Like the adults, the nymphs are covered with numerous setae, usually branched and often thickened or curiously ornate. Nymphs of the Microtrombidiinae and Trombiculinae may be distinguished from adults by the presence of but four genital suckers, but in *Allothrombium* there are six in both nymphs and adults. The penal cone and sacculi (as they are called by Ewing, 1944a), characteristic of the genitalia of the adult males and females respectively, are absent in nymphs, the sexes being apparently indistinguishable. The setae on the body and appendages are sparser

than in adults and the number of coarse setae or spines on the pedipalps of nymphs is generally fewer. The more important taxonomic features of nymphs, however, such as the structure of the body hairs, the crista, the pseudostigmatic organs, the eyes, and the arrangement of combs, accessory claws, and the like on the pedipalps are not greatly different from those of the adults.

The nymphal stage is followed by another quiescent stage, the *preadult*. The preadult differs from the protonymph only in its larger size. After the formation of the preadult integument, the nymphal appendages become dry and brittle, and the preadult integument is frequently exposed by breaks in the old nymphal integument. The preadult, however, never emerges from the nymphal integument. The preadult (and hence adult) appendages do not form within those of the nymph, but are folded inside the body of the nymph. The relation of developing adult appendages to those of the preadult is the same as that of nymphal appendages to the protonymph.

TABLE I

CHARACTERISTICS OF THE PROTONYMPHS AND PREADULTS OF THREE SUBFAMILIES OF TROMBIDIIDAE

ALLOTHROMBIDIINAE	TROMBICULINAE	MICROTROMBIDIINAE
Appendages present; body fitting around appendages at rear, so that the appendages occupy a shallow concave space in venter of body; no dorsal spine, but a large longitudinal anterior dorsal groove; body surface not tuberculate but coarsely wrinkled.	Appendages present; body not fitting around them, the appendages projecting freely; anterior dorsal spine present, dorsal groove absent; body surface finely tuberculate.	Body saclike, without appendages, dorsal spine or groove; body surface often finely tuberculate.

The *adult* in the Microtrombidiinae and Trombiculinae may be recognized by the presence of six genital suckers. Other features which distinguish adults from nymphs are indicated above.

In certain species of Microtrombidiinae the adults continue to grow and molt. Each succeeding adult stadium is preceded by a quiescent stage not distinguishable from the preadult. For convenience the term preadult is applied to these stages, although actually they are between (not merely before) adult stages. Even among individuals of a single species the number of adult stadia is highly variable. Thus in *Microtrombidium maculatum*, the best known species exhibiting adult growth, the number of adult stadia may probably vary from three to seven. Information on growth in this species is shown in Table VIII. Because the body integument stretches, body growth can take place between molts. For this reason, to get information on molts, measurements were made of the last segment of the anterior leg. Although no individuals were reared through, numerous lines on the graph indicate the amount of growth accomplished at one ecdysis. This information was obtained by comparing the measurements of exuviae with the mites which emerged from them. An examination of the graph shows that the amount of growth at one molt is highly variable, ranging from as little as 0.02 mm. to as much as 0.19 mm. in the length of the last

segment of the front leg. The largest adult measured was three times the size of the smallest.

The smaller adults, here termed ***subadults*** for convenience although no clear-cut distinction can be drawn between subadults and adults, differ from larger ones in having somewhat fewer setae, although they are approximately as dense as in larger individuals. For this reason the combs of the pedipalpal tibiae have fewer setae in small than in large specimens. Thus in ***Manriquia bequaerti***, which, like ***Microtrombidium maculatum***, grows considerably as an adult, the longer comb of the pedipalpal tibia has as few as eight setae in a small subadult, as many as thirty in a larger adult.

In some species in which there is adult growth, egg laying is observed only among females of middle size and above. The genital structures appear the same, however, in large and small individuals. For example, the smallest males have a penal cone structurally indistinguishable from the largest. Growth and molting continue after the egg laying size has been reached, and it is probable that females lay several masses of eggs during their lives. In other species (eg. ***Manriquia panamensis***) even small females produce eggs.

TABLE II

Summary of Life History of Trombid Mites

Major stages...........	egg		larva		nymph		adult
Intervening stages......		deutovum		protonymph		preadult	

Even among rather closely related species, some may show adult growth and others not. Thus in ***Microtrombidium pistiae***, obviously related to ***M. maculatum***, there are normally no adult molts.

Females average somewhat larger than males in each species studied. The distinctions between the sexes of the ***Trombiculinae*** were pointed out (for ***Eutrombicula göldii***) by Boshell and Kerr (1942) and again, with illustrations, by Ewing (1944). In other subfamilies features distinguishing the sexes are about the same, except that the necks of the sacculi of the female are inconspicuous and the penal cone of the male is often turned on its side in mounting. Its several apodemes projecting into the body (figs. 29 and 30) are conspicuous.

Table II will serve as a summary of the life history. The nature of the intervening stages remains a matter of doubt. Probably they should not be considered as separate stadia. The integument of these stages consists in part of a cuticle, not affected by caustic, which is apparently laid down by a layer of epithelial cells (Henking, 1882). In these respects this integument resembles other arthropod integuments. However, the occurrence of such a stage between each major stage, regardless of the number of the latter in species molting as adults, suggests that the pupa-like quiescent stages are merely a part of the mechanism of ecdysis in this group.

ABNORMALITIES

Most of the variations observed, as for example in the number of coarse spines on the pedipalps, are considered to be within the limits of ordinary specific variation and are discussed separately under each species. A few very curious specimens have come to notice. In each case the specimens appear to be normal except for the peculiarities described.

One subadult of *Microtrombidium maculatum* was reared from a normal and apparently uninjured nymph. The subadult had the normal three genital suckers on the left side of the body, but two elongated ones on the right. The fourth leg was completely absent on the right side, the area where its coxa should have been being covered by bare and slightly tuberculate integument. The third leg on the same side was represented only by a small hairy projection about the size and shape of the distal half of the last tarsal segment, arising directly from the body without a coxa and bearing a pair of normal claws.

A nymph of the same species had a very small sucker behind the normal posterior genital sucker of one side. An adult had a very small sucker behind the median genital sucker of one side.

An adult of *Manriquia bequaerti* had four genital suckers of equal size on one side, making a total of seven. Another adult of the same species had a total of but four genital suckers, thus resembling a nymph, although the suckers were elongated.

An adult of *Manriquia panamensis* had two elongate suckers on one side, instead of the usual three. Another specimen had the posterior sucker of one side reduced to about one-fifth of the normal diameter.

TAXONOMY AND BIONOMICS

Allothrombium metae Boshell and Kerr

Allotrombidium metae Boshell and Kerr, 1942, Rev, Acad. Colombiana Cien. Exact., Física. Nat. Vol. 5, p. 126.

Adults of this species, agreeing well with the original description and ranging from 2.6 to 3.5 mm. in length, were found at Old Panama, Panama, in January, February, March, October, November, and December. One was also taken near Pacora, Panama Province, Panama, and others at Santa Rosa, Colon Province, Panama, and Juan Mina, Canal Zone, Panama.

Egg: Yellow, smooth, spherical, laid in masses of several hundred.

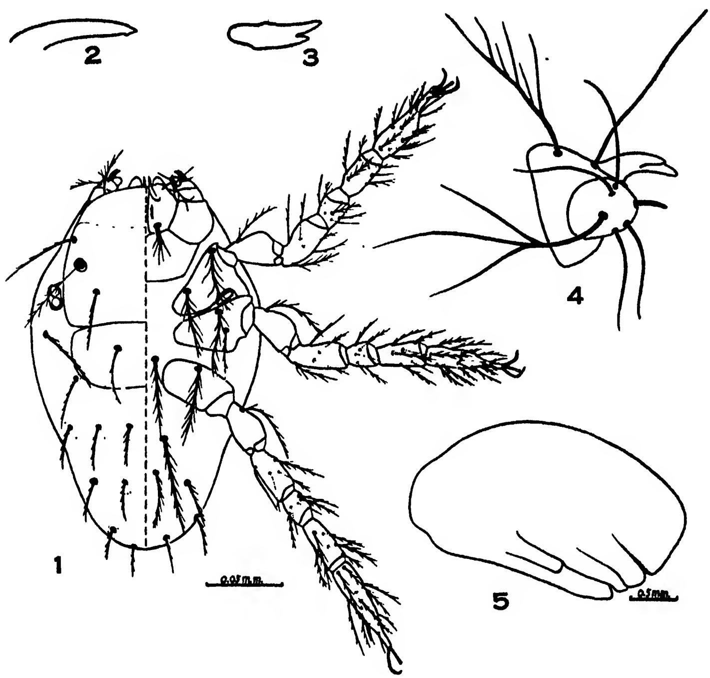
Deutovum: Dull yellow. Unfortunately none were preserved for study.

Larva: Length about 0.23 mm. when unengorged, color orange yellow; when fully engorged length 1.4 mm., color orange red. The characters are shown in the accompanying illustration. Anterior eyes commonly smaller than posterior.

Protonymph: Dull red; body surface coarsely and irregularly wrinkled, not tuberculate; leg sheaths closely appressed together and to

body; antero-dorsal portion of body with broad, deep longitudinal groove, corresponding to the groove in which the crista of the next stage lies.

Nymph: Length 1.5 mm. when freshly emerged to 2.5 mm. when ready to molt. Agreeing in general with adult, even having six genital suckers as in adult; last anterior tarsal segment little longer than tibia, instead of much longer as in adult.



Allothrombium metae Boshell and Kerr. 1, larva; 2, apex of chelicera of larva; 3, pedipalpal claw of larva; 4, apex of pedipalp of larva; 5, preadult.

Preadult: Distinguishable from protonymph only by size.

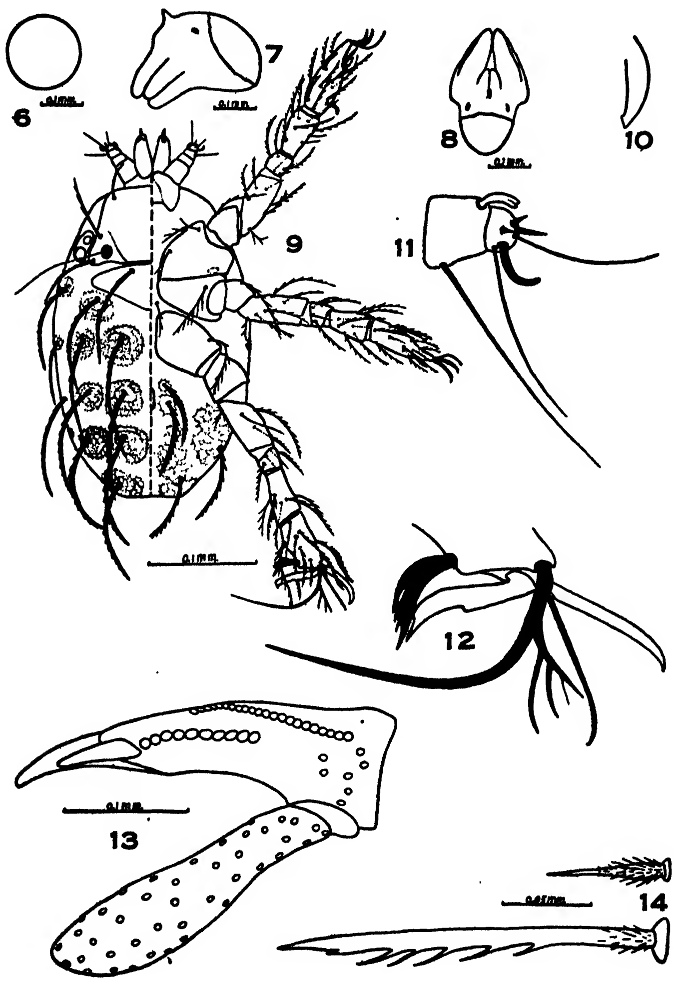
Bionomics: Nymphs and adults were usually found beneath stones, occasionally beneath logs. They are rather uncommon, and seem to disappear during the latter part of the dry season and early part of the wet season. Their movements are slow.

On January 15 at Juan Mina three very large engorged larvae were found attached to lycosid spiders of the genus *Pirata* (determined by Dr. Willis J. Gertsch). Each spider carried a single larva attached between the cephalothorax and the abdomen.

Egg masses were found beneath stones, and one was laid in the laboratory. The egg and deutoval stages are long, as larvae emerged

on May 8 from a mass laid before April 1. Two tremendously engorged larvae were found beneath a stone at Santa Rosa on November 14. Each soon became a protonymph, and three weeks later one was mounted and found to contain a nearly completely formed nymph. On December 12 after thirty days of quiescence, a nymph emerged from the other. These nymphs were similar to nymphs obtained in the field. A preadult was found beneath a stone on November 8.

From the relatively uniform size of the appendages of adults of this species it seems probable that there are no adult molts. Although this



Manriqua bequaerti Boshell and Kerr. 6, egg; 7, lateral view of deutovum; 8, dorsal view of deutovum; 9, larva; 10, apex of chelicera of larva; 11, apex of pedipalp of larva; 12, apex of posterior leg of larva; 13, inner view of tibia and tarsus of pedipalp of adult; 14, body hairs of adult.

is the largest of the mites studied, it attains its size, not by repeated molts as in the large Microtrombidiinae, but by great increase in size and stretching of the body integument during each active stage.

Manriquia bequaerti Boshell and Kerr

Manriquia bequaerti Boshell and Kerr, 1942, Rev. Acad. Colombiana Exact., Físic. Nat. Vol. 5, p. 119.

Adults of this species from Panama differ from the original description of the species in being more often dull red than reddish brown, although a few specimens were of the latter color; and in having the fingers of the pedipalps slightly exceeding the claws, at least in large specimens. The combs of the tibia of the pedipalp do not both arise close to the base of the claw, as described for *bequaerti*. One arises at the base of the accessory claw; another, more dorsal in position, arises some distance from the claw. Panamanian specimens were sent to Dr. H. E. Ewing for comparison with the types of *bequaerti*. He found them to be the same, noting particularly that only one palpal comb arises close to the base of the claw, in contrast to the original description of *bequaerti*. It may be noted that the setae of the basal (dorsal) comb are a little more slender, or at least have smaller bases, than those of the distal comb. The distal segment of the anterior tarsus varies in shape, but is usually more than twice as long as broad, contrary to the description of by Boshell and Kerr. Indeed the photograph given by these authors shows it more than twice as long as broad.

Adults were collected at Old Panama, Panama; near the landing at Barro Colorado Island, Canal Zone, Panama; and at Santa Rosa and Pina, Colon Province, Panama.

As with other species which grow and molt as adults there is great variation in size and in the number of bristles in the pedipalpal combs in *M. bequaerti*. Subadults have been collected which were only 0.77 mm. in length, while the largest adults were 2.4 mm. long. The variation in the number of bristles in the pedipalpal combs is in general correlated with size, but there is much variation in this matter, as shown in Table III. Here the numbers of bristles in the combs and the length of the last segment of the foreleg are shown for certain specimens selected to demonstrate the extent of the variation. There is frequently a difference of one or two in the number of bristles in the combs of the two pedipalps of a single individual. When the setae of both pedipalps could be accurately counted and a difference was noted, it is indicated by a double entry in the columns of this table.

Usually but not always there are two large simple bristles basad of the large spine, on the outer side of the tibia of the pedipalp. Sometimes there is but one such bristle, and in one specimen a bristle was present on one side, absent on the other.

There is noticeable variation also, not correlated with size or number of setae in the combs, in the body hairs. The larger hairs are often longer and more slender than in the figure. Large hairs which are not at all swollen at the base lack the small setulae shown in the figure, but those which are slightly swollen have such setulae. Occasionally a

specimen is found having a few small setulae throughout the length of the large hairs. The number of large teeth on the large hairs varies from two or three to over ten. Small hairs are sometimes setulose to the apices.

All these variations have been observed in specimens collected at Old Panama at the same time under the same group of rocks.

Egg: Orange, smooth, spherical, averaging about 0.18 mm. in diameter, laid in masses of 50 to 100. On breaking, anterior portion of shell falls completely away, the posterior remains around the posterior portion of the deutovum.

Deutovum: Orange red with single dorsal spine; body surface with scattered fine sharp papillae.

Larva: Length about 0.29 mm. when unengorged. Color red. The characters are shown in the accompanying illustration.

TABLE III

NUMBERS OF SETAE IN PEDIPALPAL COMBS AND LENGTH OF LAST ANTERIOR TARSAL SEGMENT IN SELECTED ADULT SPECIMENS OF *Mantiquia bequaerti*

Setae in Basal Comb	Setae in Distal Comb	Length (mm.) of Last Anterior Tarsal Segment	
24	14–13	.77	Largest specimen
10	6	.27	Smallest specimen
30–29 8	16 6	.66 .29	Longest and shortest basal combs
26 22 9	17–16 17 5	.74 .63 .29	Longest and shortest distal combs
12–11 21 15	9 14 10	.33 .55 .45	Combs not greatly different in length
13 20 26	7 10 13–15	.40 .59 .66	Combs of widely different lengths

There are several differences between the larva and the description of Boshell and Kerr. They state, for example, that the second dorsal plate has four setae, while it has but two in Panamanian specimens. These differences are evidently more apparent than real, however, since their material was evidently poor. The extra pair of setae which they describe as arising from the second dorsal plate is present, but does not arise from the plate.

The inner hair of the anterior coxa is often trifid instead of bifid as shown. In one "freak" larva studied there are three instead of two midventral abdominal hairs on one side, and on the same side of the body there is an extra antero-lateral seta on the anterior dorsal plate.

Protonymph: Unknown.

Nymph: Length 0.52–0.77 mm. Agreeing with the adult except for the usual nymphal features. Basal comb of pedipalps with four to five bristles, distal with four; body hairs noticeably sparser than in adults.

Preadult: Sac-like, surface practically smooth. Color red.

Bionomics: All stages of this mite have been collected beneath stones, and an occasional individual has been found beneath a log or in leaf mold. It is the most common trombidiid beneath stones among the ruins of Old Panama, although not much more abundant than *M. panamensis*. Adults of all sizes have been found at all seasons of the year, although at Old Panama specimens were very difficult to find during the last of the dry season and first part of the rainy season (May to July). The few nymphs obtained were found in August and October, eggs in May and August. Although long-legged, these mites are usually very sluggish in their movements.

Egg masses have been found under stones in the field, and have been laid in the soil in a rearing jar in the laboratory. The meagre information available on the duration of the egg and deutoval stages is as follows: eggs found in field on May 12, 1945, were in deutoval stage by May 20, larvae emerged May 30 to June 3; eggs laid in the laboratory on May 30 reached the deutoval stage about June 14 and larvae emerged June 26 to 28.

There is no information on the duration of the other stages, except that field collected preadults have remained in that stage for as much as fourteen days before transforming.

In this species there are several adult molts. Table IV, in which the length of the last anterior tarsal segment is used as an index of size and lines indicate the growth of certain individuals at one molt, shows all available data on growth. Unlike *M. panamensis*, egg laying probably does not begin until the females reach middle size. At each molt, there is an increase in size as well as in number of bristles of the pedipalpal combs. The amount of increase in size is well correlated with the number of additional bristles acquired. Thus in two cases in which the amount of growth of the last anterior tarsal segment was 0.04 mm. at a molt there was only one seta added to each pedipalpal comb. On the other hand, in one specimen in which the amount of growth was 0.16 mm. there were four bristles added to the distal comb and five to the basal comb.

Manriquia panamensis n. sp.

Adult: A moderate sized red species with body hairs of two types, both pointed at tips, the larger type with branches of one side thickened and dense distally giving each hair a club-like appearance at low magnifications.

Length 1.5 mm. (varying from 0.8 to 1.8 mm. among paratypes).

Pedipalps reaching to middle (or apex) of patella of foreleg; claw less than half as long as distal process of chelicera (more than half as long in some paratypes); outer side of tibia with a slender spine[4] varying from two-thirds as long to as long as claw and arising about midway between base of claw and base of finger; inner side of tibia with an accessory claw half as long as principal claw, and two combs of bristles,

[4]The thickness of this spine varies. It is rather unusually long and slender in figure 16. Sometimes it is entirely lacking; in other specimens it is preceded by two small spines or by two large ones so that there is a row of three spines, the basal one above the base of the finger.

TABLE IV

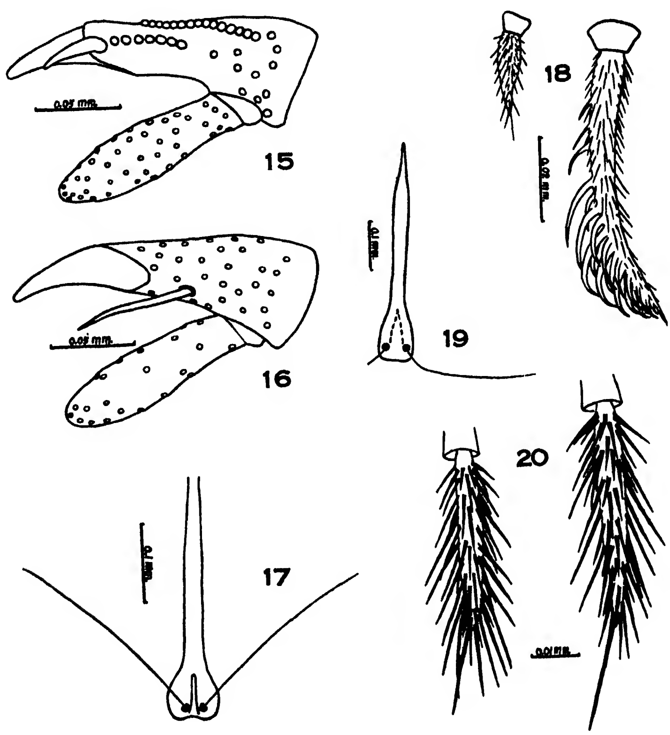
Manriquia bequaerti

FREQUENCY DISTRIBUTION OF MEASUREMENTS (IN MILLIMETERS) OF LAST SEGMENT OF FORELEG

N=nymphs, M=adult males, F=adult females. Figures under "eggs" show the number of individuals in each size class which laid or contained eggs. Lines under "growth of individuals" show the amount of growth at one molt of certain individual mites.

	N	M	F	Eggs	Growth of Individuals	
					Males	Females
.19-.20	1					
.21-.22	2					
.23-.24						
.25-.26						
.27-.28		1	2			
.29-.30		2	2			
.31-.32						
.33-.34		2	2			
.35-.36		3				
.37-.38		2	2			
.39-.40		2	1			
.41-.42		1	3			
.43-.44		8	1			
.45-.46		2	1			
.47-.48		1	4			
.49-.50		6	4			
.51-.52		2	1			
.53-.54		3	1	1		
.55-.56		5	4	2		
.57-.58		3	1			
.59-.60		2	3			
.61-.62		3				
.63-.64		3	1			
.65-.66		1	5	1		
.67-.68			1			
.69-.70			3			
.71-.72						
.73-.74			1			
.75-.76						
.77-.78			1			

the distal one of about seven (three to thirteen in adult paratypes of various sizes) bristles extending from the middle of the segment to the accessory claw, the basal (or upper) one of about sixteen (four to twenty-one in adult paratypes of various sizes) bristles extending from the end of the first fourth of the segment to the end of the third fourth; bristles of distal comb scarcely larger than those of basal comb; finger reaching apex of claw, its setae and most of those of outer side of tibia plumose. *Chelicerae* with distal process sickle-shaped, sharply pointed apically, the



Manriquia panamensis Michener. 15, inner view of tibia and tarsus of pedipalp of adult; 16, outer view of same; 17, crista of adult; 18, body hairs of adult.
Manriquia boshelli Michener. 19, crista of adult; 20, body hairs of adult.

concave margin minutely dentate. *Crista* rod-like, expanded posteriorly into a rounded pseudostigmatic area somewhat wider than long; pseudostigmatic organs simple, arising from cup-like depressions with sharp elevated margins in posterior lateral positions of pseudostigmatic area. *Eyes* sessile, posterior ones much smaller than anterior. *Body hairs* dorsally of two types; larger type more abundant posteriorly than anteriorly, arising from short thick papillae which are much broader basally than apically, main axis of hair curved, thickest near base, tapering near apex to slender sharp point (which in some specimens does not project beyond setulae as in figure 18); main axis covered on

concave side and base of convex side with numerous small hairlike setulae, remainder of convex side with numerous thickened curved setulae which often give entire hair a club-like aspect; smaller type of dorsal hair arising from papillae similar in shape to those of larger hairs, main axis much thickened but tapering to a sharp point and covered with numerous small setulae; venter anteriorly and around genital opening with rather elongate hairs of the small type, posteriorly with large type in addition; area anterior and lateral to eyes with slender hairs of the small type only. *Legs* (also basal halves of pedipalps) with hairs, particularly of upper surfaces, similar to larger type of body hairs, those of inner surfaces of appendages and distal segments being more slender and less curved than body hairs; first and fourth pairs of legs subequal in length and slightly longer than body, other pairs shorter than body; forelegs with femur longer than patella, scarcely longer than tibia, slightly shorter than basitarsus and much shorter than the dilated distitarsus, claws about two-thirds the size of those of other legs; second and third legs each with femur slightly longer than patella, slightly shorter than or subequal to tibia, and scarcely two-thirds length of each of the tarsal segments; fourth legs with femur, patella, and tibia subequal, tarsal segments longer, equal to each other (or the first a little longer than the second).

Holotype male: Old Panama, Panama, January 10, 1945, under stone (C. D. Michener). *Allotype* female and eighty-three *paratypes* from the same locality dated January 10, March 1 and 5, May 29, August 16 and 30, October 5, and November 10, 1945. This is a very common species at Old Panama. Additional specimens are from Chiva Chiva, Juan Mina, and Barro Colorado Island, Canal Zone, Panama; Santa Rosa and Pina, Colon Province, Panama; and three miles southwest of Arraijan, Panama Province, Panama.

Since adult growth occurs in this species, there is great variation in size of adults, the smallest subadults being only 0.7 mm. in length. Associated with the variation in size is variation in the numbers of setae in the combs of the pedipalps. In general, the smaller the specimen the fewer the setae in these combs, but there is great variation in this correlation, as shown in Table V, in which data on specimens showing extreme conditions of various sorts is presented, to give an idea of the extremes of the variation. The number of setae on combs of the two sides of the body frequently varies by one or two, very rarely more. When such variation was noted it is shown in this table.

Among specimens from localities other than Old Panama, there is some variation in the structure of the larger body hairs. These hairs are more slender apically in some, with the larger setulae more slender than in figure 18.

This species appears to be most closely related to *M. manriquei* Boshell and Kerr but differs, apparently, by the relatively longer fingers of the pedipalps, the usually fewer bristles in the combs of the pedipalpal tibiae, the presence of fine setulae on the concave sides of the large body hairs, and the more slender legs. In the figure of *M. manriquei* the last tarsal segment of the second, third, and fourth pairs of legs is clearly more slender than the next to the last segment, while they are of equal width in *panamensis*. The species is also evidently

TABLE V

NUMBERS OF SETAE IN PEDIPALPAL COMBS AND LENGTH OF LAST ANTERIOR TARSAL SEGMENT IN SELECTED ADULT SPECIMENS OF *Manriquia panamensis*

Setae in Basal Comb	Setae in Distal Comb	Length (mm.) of Last Anterior Tarsal Segment	
16	6-7	.44	Largest specimen
4	3	.18	Smallest specimen
17-21 20 4	13 7 3	.33 .41 .18	Longest and shortest basal combs
17-21 4	13 3	.33 .18	Longest and shortest distal combs
9 11 9	9 9 7	35 .33 .24	Combs equal or nearly so
5-6 9 13	5 4 8	.22 .22 25	Specimens of small size

TABLE VI

Manriquia panamensis

FREQUENCY DISTRIBUTION OF MEASUREMENTS (IN MILLIMETERS) OF LAST SEGMENT OF FORELEG

N=nymphs, M=adult males, F=adult females. Figures under "eggs" show the number of individuals of each size class which contained eggs. Line under "growth of individual" shows the amount of growth of one female at one molt.

	N	M	F	Eggs	Growth of Individual
.15-.16	1				
.17-.18	1	1			
.19-.20					
.21-.22		1	2		
.23-.24		1			
.25-.26		3	3	1	
.27-.28		2			
.29-.30		3	3		
.31-.32		5	1		
.33-.34		11	4	1	
.25-.26		6	2		
.37-.38		3	5		
.39-.40		5	9		
.41-.42			2		
.43-.44			2	1	

related to the European *Microtrombidium sardoum* Berlese, and to the American *Microtrombidium modestum* Berlese, both of which should apparently be placed in *Manriquia*.

Egg: Similar to that of *M. bequaerti*, about 0.18 mm. in diameter. The eggs are probably laid in clusters as a number of eggs have been found within the body of a single mite.

Deutovum: Unknown.

Larva: Apparently indistinguishable from that of *M. bequaerti*. On June 24, 1945, larvae were found in a culture jar which had contained adults of this species for slightly over a month.

Protonymph: Unknown.

Nymph: Length 0.7 mm. Agreeing with description and figures of adult except as follows: Basal comb of tibia of pedipalp with four to six setae, distal comb of three to five; crista with an internal projection extending behind pseudostigmatic area, just as in both adults and nymphs of *Microtrombidium maculatum* and *pistiae*, body hairs rather sparse, larger type somewhat less thickened and thickened hairs of appendages more slender than those of adults.

Preadult: Saclike. Color red.

Bionomics: This species has been found under stones, under logs, in rotten logs, inside of a hollow tree several feet above the ground, in leaf mold and among the roots of grasses. Small as well as large individuals have been found at all seasons of the year, but at Old Panama, where it occurs chiefly under stones, this species became scarce during the latter part of the dry season of 1945.

Table VI shows that the adult growth is similar to that of *Microtrombidium maculatum* and *Manriquia bequaerti*. The most striking feature is that eggs are evidently laid by relatively small females.

Manriquia boshelli n. sp.

Adult: A moderate sized red species with body hairs essentially of a single type, pointed apically and densely plumose.

Length 1.5 mm. (varying from 1.0 to 2.1 mm. among the paratypes).

Pedipalps reaching to apex (or middle) of patella of front leg; principal claw more than half as long as process of chelicera; tibia with slender spine about as long as claw arising on outer side near base of finger; inner side of tibia with accessory claw half as long as principal claw and with two combs of bristles, the distal one of eleven (varying from six to twelve among paratypes) bristles extending from near middle of segment to accessory claw, the basal (upper) one of eighteen (ten to twenty-four among paratypes) bristles with its basal and distinctly nearer to base of segment than distal end is to apex of segment; bristles of distal comb coarser, having larger bases, than those of basal comb; setae of inner side of tibiae which are not in combs are unusually long and coarse, unbranched; finger slightly exceeding claw, parallel-sided, its setae and those of outer side of tibia plumose. (Apex of pedipalp about as figured for *M. bequaerti* except for the larger claw and parallel-sided finger.) *Chelicerae* with process sickle-shaped, sharply pointed, the concave margin minutely denticulate. *Crista* thick, rod-like, expanded posteriorly into a pseudostigmatic area which is longer than wide,

rounded posteriorly; pseudostigmatic organs simple. *Eyes* sessile, posterior ones slightly smaller than anterior. *Body hairs* arising from short subcylindrical papillae which are slightly wider distally than basally (or in small specimens slightly wider basally than distally); body hairs densely plumose, the main axes slightly thickened, apices sharply pointed; posterior portion of body with an intermixture of similar but slightly shorter hairs, lacking the slender free apex (figure 20). *Genitalia* with longer apodemes of penal cone fully as long as cone. *Legs* and most of pedipalps covered with a mixture of slender plumose and slender simple hairs none of them thickened like the body hairs although some of the plumose hairs are slightly thickened near bases; fourth pair of legs longest, first slightly shorter and about as long as body, second and third considerably shorter; forelegs with femur longer than patella, equal to tibia, slightly shorter than basitarsus, much shorter than the dilated distitarsus, claws about two-thirds the size of those of

TABLE VII

NUMBERS OF SETAE IN PEDIPALPAL COMBS AND LENGTH OF LAST ANTERIOR TARSAL SEGMENT IN SELECTED ADULT SPECIMENS OF *Manriquia boshelli*

Setae in Basal Comb	Setae in Distal Comb	Length (mm.) of Last Anterior Tarsal Segment	
22	12	.51	Largest specimen
11	7	.29	Smallest specimen
24 10	12 7	.44 .33	Longest and shortest basal combs
21 15	12 6–7	.48 .33	Longest and shortest distal combs
14 15–16	10 12–7	.39 .47	Combs not greatly different in length
20	9	.44	Combs of widely different lengths

other legs; second and third legs with femora and following segments progressively increasing in length; fourth legs thick except for the rather slender distitarsi, patella the thickest segment, trochanter swollen, femur, patella, tibia, and basitarsus progressively longer, distitarsus as long as tibia; pits from which hairs arise on fourth legs unusually large, so that seen in profile the margins of the segments appear dentate.

Holotype male, *allotype* female and four *paratypes*: Old Panama, Panama, August 16, 1945, under stone. Two paratypes, same locality, October 5 and November 8, 1945. Seven paratypes, Santa Rosa, Colon Province, Panama, September 10, 1945. Additional specimens are from Juan Mina, Canal Zone, Panama (R. Melvin).

The great variation in adult size of this species indicates that, as in other species of *Manriquia* studied, there is adult growth. Table VII shows, for certain selected individuals, the length of the last segment of the foreleg and the number of bristles in the pedipalpal combs.

This species seems to be related to *M. bolivarensis* Boshell and Kerr and *M. rocae* Boshell and Kerr. It differs from both in the thickened

body hairs with numerous branches and in the elongate pseudostigmatic area. It differs further from *M. rocae* in the larger posterior legs, and from *M. bolivarensis* in the longer pedipalpal claws.

Egg: Red, smooth, spherical, 0.16 to 0.19 mm. in diameter, probably laid in masses since one female collected August 16, 1945, contained 71 eggs.

Deutovum: Unknown.

Larva: Unknown.

Protonymph: Unknown.

Nymph: Length 0.9 mm. Agreeing with description of adult except for the usual nymphal characteristics. Distal comb of pedipalpal tibia with five to six bristles, basal with seven; body hairs sparser than in adult, their papillae slightly wider basally than distally.

Preadult: Unknown.

Bionomics: This species has been found under stones, under logs, and in rotting logs. It is much less common than either *M. bequaerti* or *panamensis*. Because of the variability of adults, it is quite certain that adult molts occur in this species, although none have been observed.

One adult remained alive in a rearing jar containing a small amount of earth for six months.

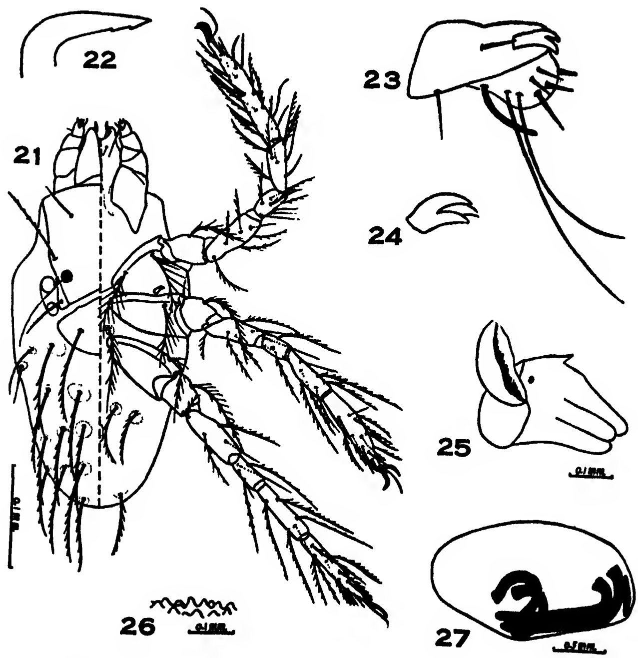
Microtrombidium maculatum n. sp.

Adult: This is a large red species, with small, somewhat diffuse, whitish spots produced by white hairs on the dorsal surface, these consisting of four transverse rows of three spots each, the foremost just behind the pseudostigmatic area, and behind these rows two pairs of spots. There are also white hairs at the posterior end of the body, on the venter, and on the legs. In cleared and stained specimens these spots are not visible. On each side of the principal claw of the pedipalp is a heavy spine or accessory claw, so that the pedipalp appears to be three-clawed.

Length 2.2 mm. (varying from 1.5 to 2.75 mm. among the paratypes).

Pedipalps reaching to apex of femur or middle of the patella of the anterior leg, depending on how much they are straightened in mounting; principal claw less than half as long as distal process of chelicera, on either side of principal claw is an accessory claw more than half as long as principal claw, that on outer side farther from principal claw than that on inner side; setae of inner side of tibia simple, numerous, those of distal half arranged in a comb reaching nearly to base of inner accessory claw, the comb becoming irregular basally so that it is difficult to determine where it stops; distal setae of comb progressively shortened and thickened, the terminal one about as long as (or shorter than) accessory claw; above this comb is a second and much shorter comb (sometimes so irregular as to be unrecognizable); finger approximately parallel sided (or slightly tapering), not quite reaching apex of claw, its hairs and those of outer side of claw-bearing segment finely plumose. *Chelicerae* with distal process broad, sickle-shaped, acutely pointed, with fine teeth on concave margin. *Crista* rod-like, with an internal projection extending a short distance behind pseudostigmatic area, the latter triangular, truncate behind; pseudostigmatic organs simple,

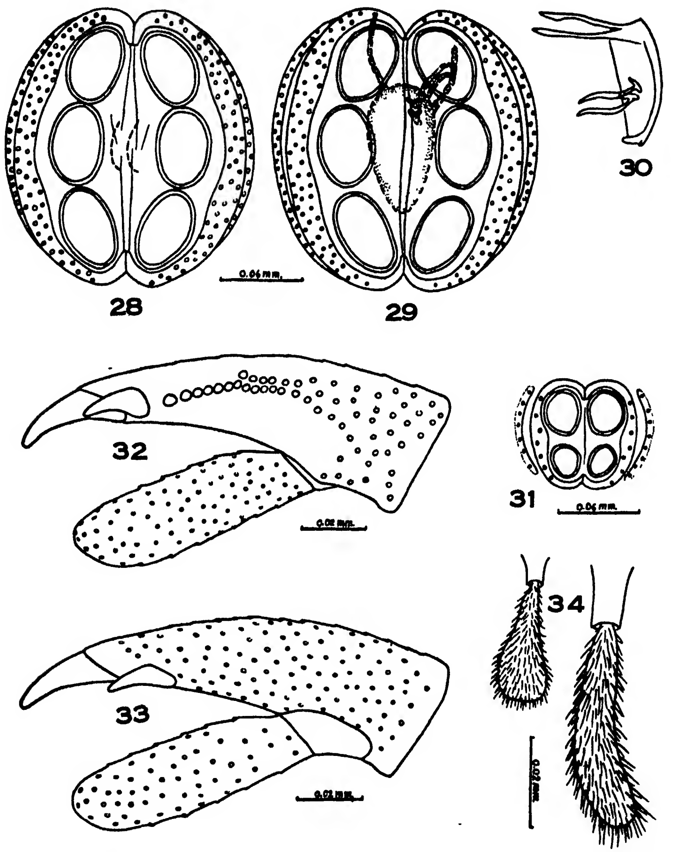
arising from posterior lateral corners of pseudostigmatic area; crista not consistently different from that of *pistiae*, but rod-like portion anterior to pseudostigmatic area often narrower than figured for that species, and sometimes expanding gradually into the pseudostigmatic area. *Eyes* elevated, sessile, in the usual position above anterior coxae, the anterior ones much larger than the posterior (which are sometimes inconspicuous or virtually absent). *Body hairs* dense, those of dorsum and sides of two sizes, arising from large elongate papillae which are widest basally, the hairs thickened, rounded apically, widest subapically,



Microtrombidium maculatum Michener. 21, larva; 22, apex of chelicera of larva; 23, apex of pedipalp of larva; 24, claw of pedipalp of larva; 25, deutovum and broken egg shell; 26, surface sculpture of preadult; 27, preadult, showing diagramatically the manner in which the adult legs are developed within.

curved, and covered with many fine setulae; hairs of venter, except marginally, of a single size, arising from smaller papillae, the hairs thickest subbasally (or medially) and tapering to a pointed apex, covered with numerous setulae. *Genitalia* with apodemes of penal cone of male shorter than cone. *Legs* with hairs but slightly thickened, pointed, plumose; fore and hind legs slightly longer than body, other pairs shorter; fore legs with femur, patella, tibia, and second tarsal segment subequal, first tarsal segment slightly longer, second tarsal segment somewhat swollen, about three times as long as broad, its claws about three-fourths the size of those of other legs; proportions of segments of other legs approximately as in *M. pistiae*.

Holotype female, *allotype* male, and sixteen *paratypes*: Juan Mina, Canal Zone, Panama, June 10, 1945. One hundred and eighty-one additional paratypes from the same locality, March 15, August 23, September 12, and October 17, 1945. All were collected by the author in company with *M. pistiae* on the undersides of leaves of floating plants of *Pistia stratiotes*. Additional specimens were collected from a roadside ditch near Juan Diaz, Panama Province, Panama (R. Melvin).



Microtrombidium maculatum Michener. 28, genital area of adult female; 29, genital area of adult male; 30, lateral view of penal cone of adult male; 31, genital area of nymph; 32, inner view of tibia and tarsus of pedipalp of adult; 33, outer view of same; 34, body hairs of adult.

Since adult growth occurs in this species there is great variation in the size of adults and subadults. Subadults have been collected as small as .85 mm. in length. Structurally they are similar to large adults. Since there are fewer setae on small individuals the pedipalpal combs contain fewer setae, the longer comb having as few as eight in

some individuals. The principal claw of the pedipalp in small sub-adults is more than half as long as the distal process of the chelicera.

This species resembles *M. arborealis* Boshell and Kerr in some respects. That species, however, has two long combs on the tibia of the pedipalp, greater differentiation of the two sizes of body hairs and greatly modified posterior legs. In both larval and adult characters *maculatum* is related to *pistiae*, from which it differs most obviously in the nature of the body hairs. *M. maculatum* may be related to *M. 13-maculatum* Berlese, but the latter apparently lacks the inner accessory claw of the pedipalp.

Egg: Bright red, smooth, spherical, about 0.17 mm. in diameter, laid in masses of 120 to 200, enveloped in a translucent gelatinous material, unlike anything observed with other Trombidiidae. The chorion, on breaking, does not usually separate into two completely separate portions (see figure 4).

Deutovum: Similar to that of *M. pistiae*, having two dorsal spines, but the leg sheaths shorter than in that species; surface finely papillate in some areas.

Larva: Length 0.32 mm. when unengorged; when engorged up to 0.66 mm. Color red. The characters of the larvae are shown in the accompanying illustration. The pedipalpal claw often appears bilobed instead of trifid because of the curvature of the claw.

Protonymph: Saclike, finely tuberculate. Color red.

Nymph: Length 0.65 to 1.1 mm. Agreeing with the description and figures of adult except as follows: principal claw of pedipalp considerably more than half as long as process of chelicera; finger of pedipalp tapering toward blunt apex, considerably exceeded by claw; combs of pedipalpal tibia shorter, becoming irregular basally like those of adult so that it is difficult to state the number of setae; upper comb usually unrecognizable, consisting of one or two setae, longer lower comb consisting of four to seven setae; genital area with but two pairs of suckers; body hairs as in the adult but much sparser; legs with proportions of segments different from the adult, the two tarsal segments of the posterior leg being subequal.

Preadult: Differs from protonymph only in larger size.

Bionomics: Except for an occasional stray individual on other species of aquatic plants, nymphs and adults of this mite have been found only on floating plants of water lettuce, *Pistia stratiotes*. In sloughs along the Chagres River near Juan Mina, Panama Canal Zone, this plant sometimes forms dense patches in which *M. maculatum* is abundant and even conspicuous. Although this and other *Pistia*-inhabiting mites were found in numerous localities near Juan Mina, the most favorable of these places was in the Rio Hondo, a tributary of the Chagres just outside the Canal Zone boundary. The under surface of the thick, spongy *Pistia* leaves are coarsely ribbed or grooved and provided with numerous large hairs, and at the bases of several of the grooves are deep pits in the leaves of large plants. Except for the parasitic larval stage, this mite apparently normally spends its entire life in the protection of the grooves and pits of the *Pistia* leaves.

Although rather sluggish in its movements, these mites are able to walk easily on the water surface when disturbed. They quickly retreat

to *Pistia* leaves, however, if necessary pushing their way under water to get beneath the margins of the leaves. The mites do not get wet, their bodies being strongly hydrophobic.

All stages of the development of this mite have been found in practically every month of the year. The only obvious effect of the season on the abundance of the species results from the influence of varying water levels on the abundance of *Pistia*.

The large egg masses, enveloped in a translucent gelatinous material, are placed in grooves on the under sides of *Pistia* leaves. Eggs laid in the laboratory required at least eight days for the deutovum to appear. When the deutovum appears the egg shell breaks into anterior and posterior portions, but instead of becoming entirely separate, the anterior portion usually remains narrowly attached to the posterior at one side (see fig. 25). The deutoval stage, six to nine days in duration, is passed in the gelatinous matrix in which the eggs are imbedded.

The larvae, after working their way out of the gelatinous mass surrounding the eggs, crawl around actively on the *Pistia* leaves and on the water surface. Some individuals remained alive without feeding for thirty days, walking about on the surface of water in a jar. Most, however, died in a shorter period of time.

Engorged larvae have been found attached to mosquitoes (*Mansonia titillans* (Walker) and *M. nigricans* (Coquillett)) collected at Gatuncillo, Colon Province, Panama, by H. Trapido, as well as at Juan Mina. Most of the mites found on mosquitoes at these localities, however, were not trombidiids. The larvae of *M. titillans* at least are frequent on the roots of *Pistia*. On the mosquitoes, the mite larvae attach themselves to the intersclerotic membranes, for example, the cervical membrane, the membranes at the bases of the coxae, and less frequently the abdominal membranes.

Larval mites did not attach to *Anopheles albimanus* Wiedemann when adults of this mosquito were put in jars with the mites nor when adults emerged from pupae placed in a jar of water on the surface of which were many mites.

After engorgement the larva leaves its host, and engorged larvae are occasionally found on *Pistia* plants. The quiescent protonymph stage is apparently usually passed in a protected place on the under surface of a *Pistia* leaf. The duration of this stage is unknown but nymphs did not emerge from field collected protonymphs for as much as five days after the time of collection.

The duration of the nymphal stage is unknown. The quiescent preadult stages apparently have a duration of about ten days.

This species is characterized by a varying but relatively large number (probably two to six) of adult molts. Table VIII, using the length of the last segment of the foreleg as an index of size, and indicating by lines the differences in size between particular exuviae and the mites emerged from them, shows all the available information concerning growth. It is evident that the amount of growth occurring at the time of ecdysis is highly variable, and also that molting may take place after the egg laying size is reached. This last is emphasized by a gravid female, collected while quiescent, and with a preadult integument clearly developing around her internal organs and eggs.

Adults which have freshly emerged from the preceding preadult stage appear dark red and wet. The white spots are not visible until the body hairs dry.

TABLE VIII

Microtrombidium maculatum

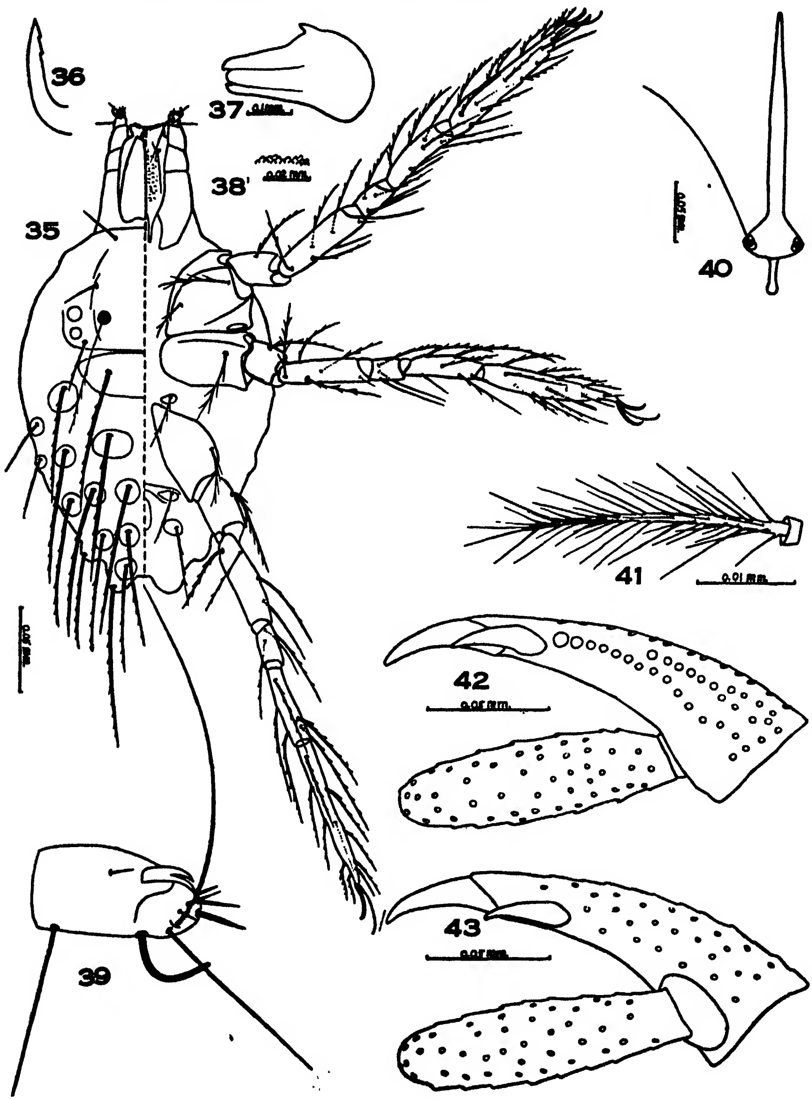
FREQUENCY DISTRIBUTION OF MEASUREMENTS (IN MILLIMETERS) OF LAST SEGMENT OF FORELEG

N = nymphs, M = adult males, F = adult females. Figures under "eggs" show the number of individuals in each size class which laid or contained eggs. Lines under "growth of individuals" show the amount of growth at one molt of certain individual mites.

	N	M	F	Eggs	Growth of Individuals	
					Males	Females
.13–.14	1					
.15–.16	11					
.17–.18	11					
.19–.20	2					
.21–.22		8	1			
.23–.24		6	1			
.25–.26		2	5			
.27–.28		6	4			
.29–.30		5	5			
.31–.32		1	2			
.33–.34		9	7			
.35–.36		3	2			
.37–.38		6	6			
.39–.40		16	11			
.41–.42		8	8			
.43–.44		16	10			
.45–.46		4	1			
.47–.48		5	7	2		
.49–.50		2	9	5		
.51–.52			10	3		
.53–.54		4	5	1		
.55–.56			13	6		
.57–.58			4	2		
.59–.60			5	1		
.61–.62			3	1		
.63–.64						
.65–.66			1	1		

Microtrombidium pistiae n. sp.

Adult: A rather small red or brownish-red, or occasionally brown, species with body hairs of a single type, unthickened and plumose. On each side of the principal claw of the pedipalp is a heavy spine, so that the pedipalp appears to be three-clawed.



Microtrombidium pistiae Michener. 35, larva; 36, apex of chelicera of larva; 37, deutovum; 38, surface sculpture of deutovum; 39, apex of pedipalp of larva; 40, crista of adult; 41, body hairs of adult; 42, inner view of tibia and tarsus of pedipalp of adult; 43, outer view of same.

Length 1.0 mm. (varying from 0.8 mm. to 1.5 mm. among the paratypes and to 2 mm. among other individuals).

Pedipalps reaching beyond the middle of the patella of the anterior legs (or in some reaching only base of patella); principal claw about half as long as distal process of chelicera; on either side of principal claw is an accessory claw about two-thirds as long as principal claw, that on outer side farther from principal claw than that on inner side; setae of inner side of claw bearing segment simple, most of them arranged into two combs, each of which becomes somewhat irregular basally so that it is difficult to state the number of setae in the combs, in some paratypes combs are longer and more regular than in figure; combs close together so that under low power they may appear as one; distal setae of distal (lower) comb progressively shortened and thickened, the distal one about as long as accessory claw; finger more or less parallel sided, reaching apex of claw, its hairs and those of outer side of claw-bearing segment finely plumose. *Chelicerae* with distal process broad, sickle-shaped, acutely pointed, with fine teeth on concave margin. *Crista* rod-like, with an internal projection extending a short distance behind the pseudostigmatic area which is transverse, truncate behind; pseudostigmatic organs simple, arising from lateral angles of pseudostigmatic area. *Eyes* elevated, sessile, in the usual position above anterior coxae, the anterior ones considerably (or but slightly) larger than the posterior. *Body hairs* dense, of a single type, arising from small papillae which are broadest distally; hairs not thickened, main axis broadest at base, strongly plumose; hairs of posterior part of body not longer than those of shoulders. *Genitalia*: Apodemes of penal cone of male considerably longer than cone. *Legs* with many plumose hairs with shorter branches than the body hairs; first and fourth pairs longer than the body (except in individuals whose bodies are swollen, as gravid females), others scarcely shorter than body; forelegs with femora about equal in length to the last tarsal segment and only slightly longer than the intervening three subequal segments (in some all five segments subequal), last tarsal segment somewhat enlarged, two and one-half to nearly three times as long as broad, its claws about three-fourths as large as those of other segments; second and third pairs of legs with femora longer than patella, the following segments progressively longer than patella, the first tarsal segment about equal to femur; fourth legs with trochanters somewhat swollen, the following segments subequal except for the first tarsal segment which is longer than the others.

Holotype female, *allotype* male: Juna Mina, Canal Zone, Panama, March 15, 1945. One hundred and seventy-one *paratypes* from the same locality, March 7, 15, and June 10, July 2, August 8, 15, and 29, September 12, October 17, 1945. An additional specimen was collected in a roadside ditch near Juan Diaz, Panama Province, Panama (R. Melvin).

Growth during the adult stage apparently is unusual in this species, but a very few specimens which are apparently subadults have been collected. These differ from ordinary adults principally in their smaller size (length 0.7 to 0.9 mm.).

The apparently three-clawed apex of the pedipalp is somewhat similar to that of *Microtrombidium arborealis* Boshell and Kerr, a species which, however, has thickened and wholly different body hairs.

Egg: Smooth, red, spherical, about 0.15 mm. in diameter, laid in masses of 85 to 120 or more.

Deutovum: Dull red, more elongate than in other species studied, as shown in figure; two adjacent dorsal spines present, one on each side of midline of body; body surface minutely papillate.

Larva: Length about 0.24 mm. when unengorged. Color red. Larval characters are shown in the accompanying figure. Pedipalpal claw trifid as shown in *M. maculatum*, but often appearing bilobed because of the apical curvature of claw. Anterior dorsal plate defined only at its rear margin; branches of body hairs short, fine, and inconspicuous; inner hair of the anterior coxa commonly merely forked instead of three branched as shown.

Protonymph: Saclike, finely and sparsely tuberculate. Color red.

Nymph: Length 0.66 to 0.93 mm. Agreeing with the description and figures of the adult except as follows: setae of inner surface of tibia of pedipalp only about nine in number, four to six of them arranged to form a single comb of widely spaced coarse setae; finger not attaining apex of claw, finger provided with a few coarse simple setae at apex; genital area with but two pairs of suckers; body hairs sparser than in adult; anterior legs with last tarsal segment slightly longer than other segments.

Preadult: Differs from protonymph only in larger size.

Bionomics: This species occurs with *M. maculatum* on floating plants of *Pistia stratiotes*. It is about as abundant as that species or in some areas more so, although because of its smaller size and usually duller coloration it is less conspicuous. All the comments under *M. maculatum* concerning the behavior of nymphs and adults and the seasonal occurrence of the species apply also to *M. pistiae*.

Adults have been observed apparently feeding on dead bodies of chironomid midges floating on the water surface. Eggs almost completely fill the bodies of gravid females, which appear shriveled after egg laying.

In this species there are normally no molts after reaching the adult stage. This fact is indicated in Table IX in which it is shown that nymphs, in a single step, become adults of maximum size, and that even the smallest adult females are able to lay eggs. Out of approximately 190 specimens measured, however, there were three males which probably represent a subadult stage. Possibly under conditions of minimum food supply and slow growth such a stage occurs. There is no proof that such small adults (i. e., subadults) molt again in this species, but since adult molts are normal but variable in number in the related *M. maculatum*, it is possible that they occur rarely and under certain conditions in *M. pistiae*.

An examination of a series of specimens of this species always reveals some in which the body hairs are densely packed and others in which the hairs appear relatively widely separated. The former are freshly molted individuals. The latter are those which have grown, with resultant stretching of the body integument, after the molt. As this species attains full size with relatively few molts, this stretching is considerable and its effect on the density of the body hairs is noticeable.

Microtrombidiium fluminis n. sp.

Adult: A small bright red species with body hairs of a single type, thickened, blunt apically, with numerous fine branches. The finger of pedipalp is small, conical, and much exceeded by the claw.

Length 0.85 mm. (varying from 0.8 to 1.4 mm. among the paratypes).

Pedipalps reaching about middle of patella of first pair of legs; principal claw small, less than one-third as long as distal process of chelicera; inner side of tibia with accessory claw two-thirds to three-fourths as long as principal claw, arising close to the base of the latter, and with one comb of about four widely separated spines which are shorter and coarser than the scattered hairs of the segment, and

TABLE IX

Microtrombidium pistiae

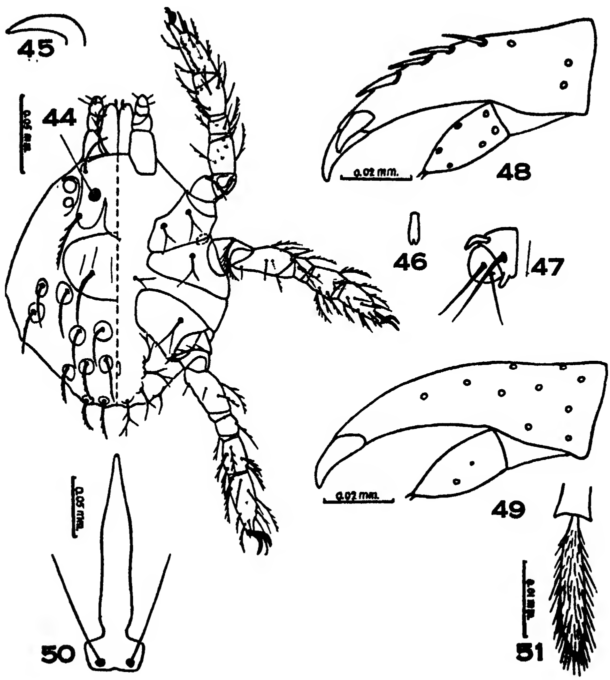
FREQUENCY DISTRIBUTION OF MEASUREMENTS (IN MILLIMETERS) OF LAST SEGMENT OF FORELEG

N=nymph, M=adult males, F=adult females. Figures under "eggs" show the number of individuals of each size class which laid or contained eggs. Lines under "growth of individuals" show the amount of growth at one molt of certain female mites.

	N	M	F	Eggs	Growth of Individuals
.13-.14	6				
.15-.16	8	3			
.17-.18		1			
.19-.20		14			
.21-.22		36	3	1	
.23-.24		23	10	1	
.25-.26		16	25	5	
.27-.28		1	24	4	
.29-.30		2	7	2	
.31-.32			1	1	

progressively coarser distally; outer side of tibia with scattered hairs only; finger small, tapering to a point, reaching to base of claw, its hairs conspicuously barbed. *Chelicerae* with distal process sickle-shaped, sharply pointed apically, the concave margin minutely dentate. *Crista* thick, tapering to a point anteriorly, slightly narrowed immediately anterior to abruptly expanded pseudostigmatic area which is wider than long and about twice as wide as crista at its widest point; pseudostigmatic organs rather short, simple. *Eyes* sessile, two on each side, anterior ones smaller than posterior; eyes not above anterior coxae but located antero-laterally from pseudostigmatic area, from which they are separated by only half width of this area. *Body hairs* of a single type, each arising from a large papilla which is broadest apically, hair arising from a cup-shaped apical concavity in papilla; hairs slender basally but otherwise much thickened, terminating bluntly, and provided with numerous fine setulae; axes of ventral hairs slightly more

slender than of dorsal ones. *Genitalia* with inner plates unusually broad, only about four times as long as broad (penal cone not clearly visible). *Legs* and pedipalps with hairs slender and for the most part plumose, not resembling the body hairs; first and fourth pairs of legs about as long as body, others shorter; forelegs with femur longer than patella, the latter equal to first tarsal segment but longer than tibia, second tarsal segment longer than femur, dilated, about two and one-half times as long as broad, claws about two-thirds as large as those of other legs; second and third pairs of legs each with femur slightly longer



Microtrombidium fluminis Michener. 44, larva; 45, apex of chelicera of larva; 46, pedipalpal claw of larva; 47, apex of pedipalp of larva; 48, inner view of tibia and tarsus of pedipalp of adult; 49, outer view of same; 50, crista of adult; 51, body hair of adult.

than the subequal patella and tibia, equal in length to first tarsal segment, but much shorter than second; fourth legs with trochanters dilated, femur slightly longer than the subequal patella and tibia, much shorter than either tarsal segment, first tarsal segment scarcely shorter than second.

Holotype (male?): Summit, Canal Zone, Panama, April 4, 1945. Three *paratypes* from the same locality. Thirteen additional *paratypes* from Tocumen, Panama Province, Panama, March 25 and April 1, 1945. Specimens were also taken at Camarón, Panama Province, Panama, March 19, 1945.

The small finger of the pedipalp of this species suggests ***M. pusillum*** (Hermann), ***columbianum*** Berlese, ***balzani*** Berlese, ***confusum*** Berlese, and ***soperi*** Boshell and Kerr. Of these species only ***confusum*** has body hairs similar to those of ***fluminis***, but that species apparently differs by the more numerous and closely spaced bristles of the pedipalpal comb.

Egg: Bright red, smooth, spherical, laid in masses of about twenty

Deutovum: Observed but unfortunately not preserved for study.

Larva: Length 0.17 mm. Color red. The characters are shown in the accompanying figure. The minute pedipalpal claws appear bilobed as shown, but may actually be trifid, as with certain other species whose claws appear bilobed in certain views. Noteworthy features are the trilobate anterior dorsal plate, the simple claws of the posterior legs, and the absence of median claws on the front and middle legs.

Protonymph: Unknown.

Nymph: Length 0.6 mm. Bristles of comb of pedipalpal tibia slender, three in number; crista almost or completely broken just in front of pseudostigmatic area; pubescence sparse, the body hairs much more slender than in adults but nevertheless distinctly thickened and ending bluntly.

Preadult: Sac-like, to judge by examination of a live specimen through nymphal integument.

Bionomics: Nymphs and adults of this species have been found running actively among moist dead and decaying leaves along the edges of pools and puddles in small drying stream beds at the end of the dry season. Some have also been taken running over damp rocks a few inches from the edges of similar pools.

The egg masses have been found in the field among the moist dead leaves where the adults occur. One was also laid in a rearing jar, among similar leaves. Larvae appeared on April 2 from a mass laid on March 26. Deutova were observed but unfortunately not preserved or described.

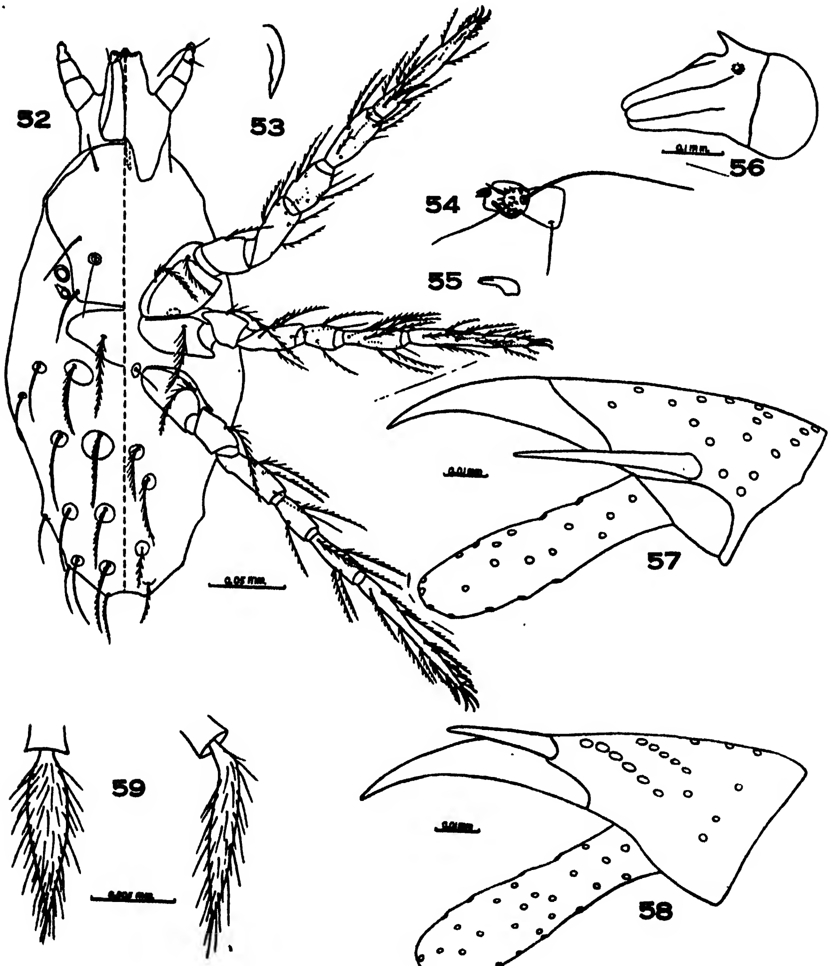
Apparently there are no adult molts in this species although evidence is meagre. All adults collected were more or less the same size. One individual was collected as a preadult. The outside integument was that of a nymph and the mite which emerged was an adult as large in measurements of the appendages as those which laid eggs.

Microtrombidium littorale n. sp.

Adult: This is a small, very bright red, rather elongate species. The hairs are of a single type in any one area of the body. They are thickened but pointed at the tips. The tibia of the pedipalp is provided with two oblique combs or bristles.

Length 1.02 mm. (varying from 0.83 to 1.10 mm. among paratypes). ***Pedipalps*** reaching middle or apex of patella of anterior leg; principal claw about as long as distal process of chelicera and approximately the length of pedipalpal tibia; inner surface of tibia with slender accessory claw about half length of principal claw and two oblique combs, each consisting of five or six coarse bristles; bristles of distal comb coarser

and with larger bases than those of basal comb (basad of combs are sometimes one to five simple setae); outer surface of tibia with large spine, nearly as long as claw, arising above base of finger; finger reaching to apex of claw, slightly more slender basally than apically, covered, like outer surface of tibia, with plumose setae. *Chelicerae* with distal process short, broad, acutely pointed, minutely dentate on concave margin. *Crista* slender, rod-like, with short internal projection, scarcely longer than broad, extending behind pseudostigmatic area; pseudostigmatic area roughly round, tapering anteriorly, with pseudostigmatic



Microtrombidium littorale Michener. 52, larva; 53, apex of chelicera of larva; 54, apex of pedipalp of larva; 55, pedipalpal claw of larva; 56, deutovum; 57, outer view of tibia and tarsus of pedipalp of adult; 58, inner view of same; 59, body hair in dorsal and lateral view.

organs arising posteriolaterally; pseudostigmatic organs simple, only about half as long as crista. *Eyes* sessile, in usual position above anterior coxae, the anterior ones slightly larger than posterior. *Body hairs* of a single type (except for certain areas), arising from large papillae which are broader distally than basally; hairs bent posteriorly near bases, somewhat flattened, narrow at bases, rather abruptly broadened near bases so that they are broadest subbasally or medially, tapering thence to pointed apices; hairs covered with numerous fine setulae; ventral hairs more slender than dorsal; areas laterad of eyes and connected by a narrow band behind pseudostigmatic area with even more slender and longer hairs, some of them scarcely thickened. *Legs* with hairs plumose, not thickened; legs râther slender, all shorter than body, anterior and posterior pairs much longer than others; fore legs with femur, tibia, and first tarsal segment subequal, patella somewhat shorter (or tibia and patella equal, both shorter than femur and first tarsal segment), second tarsal segment longer than other segments, much swollen, 2.2 (2.0 to 2.3) times as long as broad, its claws about two-thirds as large as those of other segments; second and third pairs of legs with segments following femur progressively longer, second tarsal segment much longer than any of the others, about as long as patella and tibia together; fourth pair of legs also with segments following femur progressively longer, but second tarsal segment but little (sometimes not at all) longer than first.

Holotype male, *allotype* female, and thirty-three *paratypes* from Old Panama, Panama, November 27, 1945 (C. D. and Mary H. Michener).

This species does not closely resemble any described American form. The shape of the papillae of the body hairs suggests *Microtrombidium wilsoni* Boshell and Kerr, among others, but the hairs themselves are scarcely thickened in that species. Evidently *M. littorale* is related to the European *M. stimulans* Berlese.

Egg: Bright red, smooth, spherical, 0.11 to 0.13 mm. in diameter, laid in masses of ten to thirty-five.

Deutovum: Legs elongate; dorsum with two large spines strongly diverging from one another.

Larva: Length about 0.29 mm. Color red. Characteristic features shown in fig. 52. Pedipalpal tibia with median constriction, the distal portion being flattened and projecting over the tarsus and bearing the small claw at its apex; median claws absent on first two pairs of legs; dorsal plates conspicuously longitudinally striate.

Protonymph: Unknown.

Nymph: Length 0.65 mm. Agreeing in general with description of adult; tibia of pedipalp with only one comb of three to five bristles, apparently corresponding to distal comb of adult; body hairs sparser than in adult but otherwise similar.

Preadult: Unknown.

Bionomics: This species was very abundant in an area near Old Panama. It has not been found outside of the intertidal zone, and barnacles and marine snails are found as much as four and one-half feet above the level where the mites occur. Nymphs and adults are exceedingly active and run rapidly over the surface of mud, even in bright sunlight, in a mangrove swamp as well as where mud formed a

thin covering over rocks some distance from the mangroves. The surface of the mud where these mites were collected was partly covered by an inconspicuous filamentous green alga. The broad bare mud flats evidently are not a suitable habitat for this species. When disturbed by attempts to catch them, and doubtless also by the rising tide, they go into small holes in the mud, of which there are many, mostly made by small polychaete worms.

The egg masses are laid in holes in the mud. In the laboratory it has been found necessary to remove the eggs from rearing jars as soon as possible after laying, as otherwise they are eaten by the mites. Frequent submersion in sea water does not seem to be necessary for life in this species, as the mites live well in rearing jars containing some mud kept moist by keeping the jar sealed. In such jars adults lived for over a month.

The duration of the egg stage in this species is about ten days, of the deutoval stage ten to twelve days.

There is no great variation in the size of adults in this species, and it is reasonably certain that adult molts do not occur.

Microtrombidium arborealis Boshell and Kerr

Microtrombidium arborealis Boshell and Kerr, 1942, Rev. Acad. Colombiana Cien. Exact., Físic. Nat., vol. 5, p. 123.

Specimens of this species were collected beneath a log at Santa Rosa, Colon Province, Panama, August 29, 1945. Another was found at Juan Mina, Canal Zone, Panama.

It is worth pointing out that this curious species is related to *M. distinctum* (Canestrini) from the Old World tropics.

Several other species of trombids were collected in small numbers during the author's stay in Panama. These included two species related to *Microtrombidium duartei* Boshell and Kerr, one additional species of *Manriquia*, etc.

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PROTALLAGMA RUNTUNI KENNEDY, 1939, A SYNONYM OF OXYALLAGMA DISSIDENS (SELYS), 1876: NOTES ON OXYAGRION AND RELATED GENERA

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In 1939 the writer described *Protallagma runtuni*, a Coenagriid dragonfly from the high Parana of Ecuador at elevations of 4,550 to 6,250 ft. Because of similar high elevation, similar stature, hairiness, color pattern, penis and male abdominal appendages, with only slight differences in venation it was associated with *Protallagma titicacae* (Calvert), 1909, from the similar high plains about Lake Titicacae, Peru. A thorough enough check in the scattered literature of Andean forms was not made. In a recent review of several species of Oxyagrion in the writer's collection in an attempt to identify described forms it was discovered that *Protallagma runtuni* Kennedy was described by de Selys, 1876, as *Oxyagrion dissidens* from Quito. De Selys placed this aberrant species by itself in "Group 1" of his genus Oxyagrion. The writer himself (1920) had erected the genus Oxyallagma for *dissidens* as based on material in the Williamson collection which had been sent by Campos of Guayaquil, Ecuador, with the exact locality not indicated. The description of Oxyallagma gen. nov. (1920) reads, "Characters as in Enallagma, except red a dominant color, no postocular spots, and penis without lateral lobes." *Runtuni* is thus a synonym of *Oxyallagma dissidens* (Selys).

We offer no apologies. Only one who has worked with de Sely's descriptions in Oxyagrion, and Acanthagrion will appreciate the resulting confusion and the possibility of one's forgetfulness of his own genus.

De Selys established Oxyagrion for the red species and Acanthagrion for the blue species. Curiously enough a partial check of elevations suggests that the red species (Oxyagrion) are usually found at lower elevations while the blue species (Acanthagrion), much more numerous, occur at low and medium elevations. We may be dealing with one large genus which can throw red forms from blue forms or *vice versa.* M. J. Leonard of Ann Arbor, University of Michigan, has an unpublished manuscript on the Acanthagrions of the Williamson and Kennedy collections. One of his sets of figures of penis and appendages of an unnamed species of Acanthagrion appear to be identical structurally with a red Oxyagrion from Brazil in the writer's collection. Actual specimens of the two (?) species have not been studied side by side. The writer hopes to compare them.

De Selys' descriptions of South American Odonata will in many cases remain enigmas until some generous and skilled European odonatist will publish careful drawings of penes, appendages, and color patterns of the de Selys type material. Good drawings are a must on

South American species. Calvert started the work and was followed later by E. B. Williamson and Ris. They have figured described species as well as their own new species.

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CATALOGO DE LOS DIPTEROS DE CHILE, by CARLOS STUARDO. 250 pages, 1946. Published by the Ministerio de Agricultura, Direccion General de Agricultura, Santiago de Chile.

A prologue by Charles P. Alexander testifies to the richness of the dipterous fauna of Chile. He states that this is true "particularly of the so-called Santiagan and Valdivian faunal districts that extend from the general vicinity of Coquimbo at near latitude 30°, southward to just beyond the 45th parallel, or to the general region of the Rio Aysen. In this approximately 1000-mile area there is to be found a concentration of generalized types of Diptera that is approximated elsewhere only in Australia and, to a lesser degree, in New Zealand." With this opinion of a leading authority on the order one must conclude that a comprehensive catalog of the flies of the region is an important contribution, as one must also agree with Dr. Alexander that a catalog is a tool of the greatest importance to the taxonomist.

Professor Stuardo lists the amazing total of 2,143 species. His introduction shows how thoroughly he has laid the foundations for the catalog, both on the basis of the literature and through the collaboration of specialists in the order. The result is an enviable example of taxonomic cataloging.

Following the introduction the titles of periodicals cited in the text are listed with the abbreviations used. The body of the work is in a very clear form. Genera and major categories are set in bold-faced type as center heads, without bibliographic entries. Under each genus specific names are also in bold-faced type and the condensed bibliographic material is indented, leaving the name of the species doubly easy to locate. Synonyms are in italics, separately paragraphed under the major bibliography of the species. Where necessary a list of "Species incertae sedis" is placed at the end of each family. The description of a new genus, *Pritchardia*, type *Hypenetes hirtipes* Macquart, on page 80, may be of interest beyond the limits of the order.

Descriptions of two new species of *Ocnea* by Dr. Curtis W. Sabrosky follow the body of the catalog.

Nineteen pages of bibliography and an index to scientific names complete the catalog.

The quality of the paper is inferior to the typography but it appears to be durable stock, capable of withstanding the abundant thumbing to which a catalog is subjected. The cover is heavy paper.

Professor Stuardo is to be congratulated on a monumental contribution to the taxonomy of South American insects.—A. W. L.

HYBRIDIZATION AND FEMALE ALBINISM IN COLIAS PHILODICE AND C. EURYTHEME. A NEW HAMPSHIRE SURVEY IN 1943 WITH SUBSEQUENT DATA

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The gradually advancing incursion of the orange-colored alfalfa butterfly (*Colias eurytheme*) into the north-eastern States, still abundantly populated by its near relative, the sulphur-yellow clover butterfly (*C. philodice*), is attended with measurable natural hybridization. This is more conveniently studied in a region such as this where *eurytheme*, formerly absent, is still relatively uncommon. In other eastern localities where *eurytheme* may exceed *philodice* in abundance, detection of hybrids, owing to the extreme variability of *eurytheme*, is more difficult.

In a study of evolutionary dynamics involving "speciation," it is essential to define "species." As here used, it is a group in large degree physiologically isolated from its nearest relatives by partial or complete lack of fertility. This, my experience shows (Gerould, '43), is true of the orange *eurytheme* and that complex of yellow sub-species, *eriphyle-philodice*, in many localities associated with it and probably derived from it. *Eurytheme* and the races of *eriphyle* (western) are in certain regions "sympatric," in the sense that they occur there together more or less simultaneously, though their food requirements so far as investigated, are somewhat different. Both lay their eggs on various members of the pea family and can be raised readily on white clover (*Trifolium repens*), though *eurytheme* thrives best on the alfalfas; *eriphyle* oviposits chiefly on white clover in mountain pastures. Hovanitz ('43) had difficulty in raising *eriphyle* of eastern California on alfalfa.

For many years *philodice* in the eastern States was geographically isolated from *eurytheme*. In the Mississippi Valley, into which *eurytheme* had already penetrated from the far west and the Rockies, it was sympatric with *philodice*, and hybridization between them occasionally but very rarely occurred. In recent years, apparently due largely to the gradual introduction of alfalfa, its preferred food plant, *eurytheme* has spread eastward in considerable abundance even to the Atlantic coast, and hybrids, once a great rarity, have recently been found in larger numbers. What influence hybridization may have upon the population, as the vigorous, brilliant-orange *eurytheme* moves eastward, is the problem which confronts us in the studies now being initiated.

In our 1940 survey at Hanover, N. H. (Gerould, 1943), *eurytheme* was still exceedingly rare. In the sample of 658 individuals collected and preserved, 648 were *philodice*, 5 *eurytheme* and 5 were hybrids. This might lead to the incorrect prediction that hybrids would later

be as common as ordinary, relatively homozygous, ***eurytheme***. The fact, however, that only a single ***eurytheme*** female was then taken suggests that the few invading ***eurytheme*** males, meeting almost no females of their own kind, found mates, if at all, among the abundant ***philodice*** females.[1] Two of these five hybrids were clearly F_1; three were paler and evidently of a backcross of ***philodice***. All were males. Their size, evenly distributed intermediate-orange coloration, and seasonal association with brilliant orange males exclude the possibility that they were "***ariadne***," the diminutive, pale and orange-spotted, late-fall-and-spring form of ***eurytheme***.

SUMMARY OF SURVEY IN 1940

(September–October)

philodice			*eurytheme*			hybrids	
	yellow	white		orange	white		
♂	♀	♀	♂	♀	♀	♂	♀
404	202	42	4	1	0	5	0 = 658
Total n = 648			5			5	
% = 98.48 ± .48			0.76 ± .34			0.76 ± .34 = 100	

Three years later (Sept.-Oct., 1943) the foreign population (***eurytheme***+hybrid) had become fairly common 9.2±.7%, n=1852). The proportion of hybrids to pure ***eurytheme*** was then no longer apparently equal, as in 1940, but had decreased to 7.0±2.0%, n=171.

Making up the whole 9.0% of foreigners were 159 ***eurytheme*** and 12 hybrids, 10 of which (8 ♂♂ + 2 ♀♀) were easily recognized as F_1 by their intermediate-orange ground color; 2 (1♂ + 1 ♀) were paler, of a backcross to ***philodice***.

The 1852 specimens collected in 1943 were preserved for re-examination and further study. Each day's catch was filed away separately. Publication of these daily records is here omitted, but, in testing the randomness of the whole sample, we may compare the 1090 collected by school children and teachers with those (762) by me personally. The percent of ***eurytheme***+hybrids in these two main lots differs. We find 7.4% in that of the school, 11.8% in my own. This difference may be due to my particular interest in the immigrants, occasionally inducing me to capture one of them rather than the nearest available ***philodice***, though a constant effort was made toward random sampling. The school percent is only 1.8% below that of the whole (viz., 9.2), whereas my own is 2.6 above it, indicating that 9.0% would be a better combined average of all ***eurytheme***+hybrids than 9.2.

Comparing the sex ratios in the two lots with that of all combined, we find altogether 60% ♂♂ + 40% ♀♀; in the school collection 60.8% are ♂♂; in mine 59.7, both practically the same.

The total population sample in 1943 stood at 90.77% ***philodice***,

[1]In experiments of 1913–'14, Gerould, '43, ***eurytheme*** males of Arizona stock showed less inclination in cages to cross with ***philodice*** females than ***philodice*** males with ***eurytheme*** females.

8.58% *eurytheme* and 0.65% hybrid. The presence of 42 *eurytheme* females showed that the 117 males of this later date had ample opportunity to mate within their own species; one such couple was captured. That they were generally doing so is indicated by the fact that the *eurytheme* caught outnumbered the hybrids 13 to 1. The total sample included 1681 *philodice*, 159 *eurytheme* and the 12 hybrids.

SUMMARY OF SURVEY OF 1943

(September–October)

philodice			*eurytheme*			hybrids		
	yellow	white		orange	white		orange	white
♂	♀	♀	♂	♀	♀	♂	♀	♀ = 1852
992	528	161	117	35	7	9	3	0
Total n = 1681			159			12		
% = 90.77 ± .68			8.58 ± .66			0.65 ± .18 = 100		

Data of 1945: Two years later (September 6–October 22), although weather conditions were generally unfavorable, on eleven sunny afternoons I collected 301 specimens, of which 24 (8. %) were *eurytheme*+ hybrids, a slight decrease from the 9. % obtained in 1943, though much larger than the 1.5% found in 1940. The percent of hybrids among them in 1945, however, was larger than in 1943 when, among 164 orange males and females, 12, or 7.3%, were hybrids. In 1945, 20.8% of the 24 orange individuals, viz., 5 (4 ♂♂ + 1 ♀) were hybrid. Included with them, however, is one male which, verging toward pure *eurytheme*, was listed as a backcross. Excluding this doubtful male, we would have 4 hybrids among the 24 orange "foreigners," or 16.6%, and 1.33% not 1.66% in this relatively small colias population sample as a whole.

SUMMARY IN 1945

philodice			*eurytheme*			hybrids		
		white			white			hybrid
♂	♀	♀	♂	♀	♀	♂	♀	♀
153	98	26	15	4	0	4	1	0 = 301
Total n = 277			19			5		
% = 92.0 ± 1.7			6.3 ± 1.4			1.66 ± .73 = 100		

It will be noted that the percent of hybrids in these *Colias* population samples as a whole in 1940 and again in 1943 was less than 1. %; in 1945 it was approximately 1.5%.

FEMALE "ALBINISM" IN RECENT NEW HAMPSHIRE SURVEYS

As is well-known, a measurable proportion of the females in any population of *Colias eurytheme* and of *C. philodice* is white. These are not genuine albinos as defined in Vertebrates, for the black borders and the orange-yellow central spots of the hind wings are like those of

their respective "colored" sisters, but the ground-color pigment (orange or yellow) has been replaced by white.

This genetically dominant white female color in northern *Colias* populations occurs in higher proportions than in southern (Hovanitz, 1944c). The percentage of white females in *Colias eurytheme* in western California was found by him to vary from 13% in extreme southern localities to 69% in North San Joaquin Valley (latitude of San Francisco).

In our earlier, or 1940, survey at Hanover, N. H. (Sept. 11–Oct. 16) the total of 244 *philodice* females caught and studied included 42 white, 202 yellow, i.e., 17.2±2.4%, white. No white female *eurytheme* was taken, and in fact only one orange female. In my note in GENETICS (Gerould, 1941), the smaller number caught by me personally was reported, agreeing with a study made in the spring of 1911 (Gerould, 1923) which also gave 16 percent white.

Three more recent surveys, two in the autumn of 1943, including that at Hanover already partially described and another at Acworth, N. H., gave further data on white female populations. In those of 1943 the help of school-children was enlisted. They were instructed to capture all the white butterflies they saw (including the "cabbage" white, *Pieris rapae*) so that we should miss no white females of *Colias*.

Acworth, N. H., is about 35 miles south of Hanover on hills 8 or 10 miles east of the Connecticut River (altitude about 1500 ft., cf. 500 at Hanover). This collection (n = 144) was made under the direction of Mr. James E. Peabody and a school teacher, Mrs. Murdough, Sept. 10–23, 1943.

It contained a slightly larger proportion of *philodice*, 91.6±2.3 per cent, n = 144, than that at Hanover (90.8±0.7%, n = 1942). The remaining 8.4% consisted of 8♂♂ and 3 orange ♀♀ of *eurytheme* too badly damaged for identification of hybrids, if any. No white *eurytheme* ♀ was caught, but 6 of the 29 *philodice* ♀♀ were white, i.e., 20.7±7.5%, a proportion very slightly smaller than that taken simultaneously at Hanover. In 1945 at Hanover, 26 of the 124 *philodice* ♀♀ (21.0±3.7%) were white.

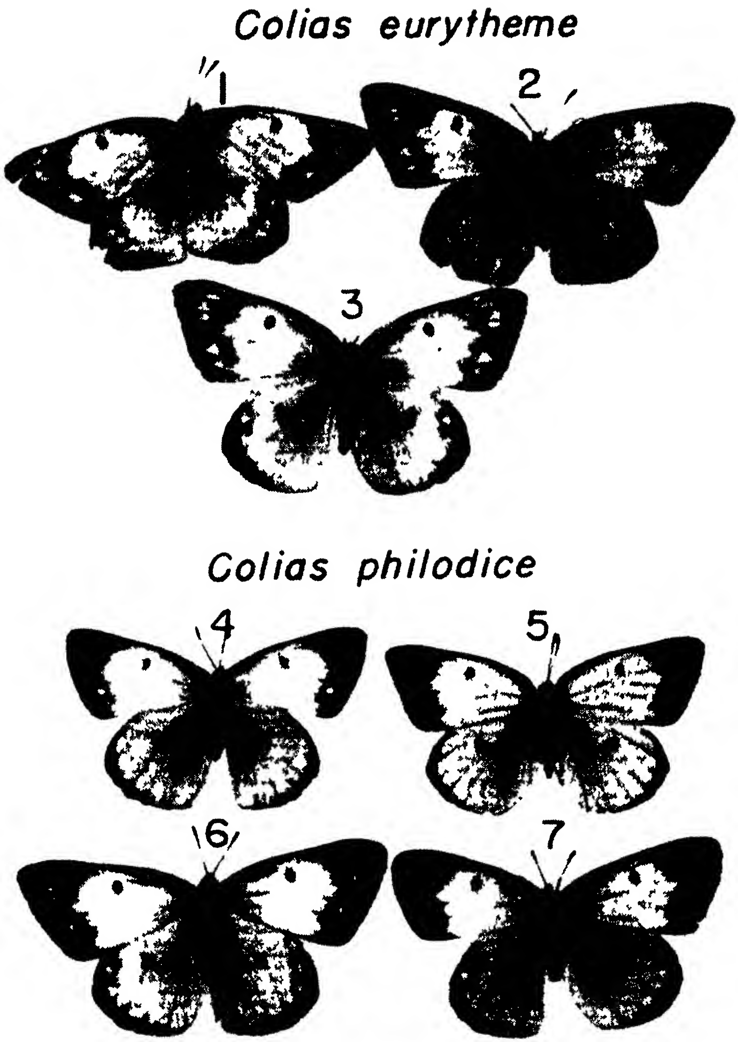
Hanover, N. H.: As already stated, the earlier, or 1940, survey gave 17.2±2.4% (n = 244) white *philodice* ♀♀. In 1943, it was 23.4±1.6% (n = 689) in *philodice*. Of *eurytheme* in 1943, 42 ♀♀ were taken, exclusive of 3 hybrids, with 117 ♂♂; 33 of these ♀♀ were orange, 7, or 16.7±5.7%, were white. Combining white ♀♀ of both *eurytheme* and *philodice* taken at Hanover in 1943, 22.9±1.5% (n = 734) were white.

Female hybrids, exclusive of whites, were 3 (0.53% of all orange ♀♀). This ratio when applied to all the whites (168) would amount to 0.89, or slightly less than one individual. None was positively identified as such.

EXPLANATION OF PLATE I

White females, natural size, from the 1943 survey.

Figs. 1–3 are *Colias eurytheme;* 4–5, typical *C. philodice;* 6–7, *C. philodice* with intermediate color pattern. 6 may be an F_1 or other hybrid, but has been listed as *philodice*. (See the text, p. 384). Fig. 1, Sept. 27 (J. H. G.); 2, Sept. 19 (Berry and Blossom); 3, Sept. 19–20 (Jr. Nat. Hist. Club); 4, Sept. 12 (J. H. G.); 5, Sept. 13 (J. H. G.); 6, Sept. 12 (J. H. G.); 7, Sept. 13 (J. H. G.).


Colias eurytheme
1
2
3
Colias philodice
4
5
6
7

Absence of ground-color contrasts in white ♀ ♀ forces one, in the study of captured specimens, to depend upon color-pattern differences in judging whether they belong to *eurytheme*, *philodice* or are possibly hybrid. Any white hybrid would be looked for among the few whites of intermediate color-pattern included in our list of 161 white ♀ *philodice*.

Before critically examining these intermediates, let us first inquire into the traits of the 7 whites regarded as unmistakably *eurytheme*. They agree in having: fore-wing black border wide, marked with an almost continuous curved row of large spots of white ground-color. Black discal spots large. Posterior (inner) half of the fore wings touched with faint orange in the 4 freshest specimens.

Hind-wing border broad, extending inward half-way to the central spot and enclosing large spots in the more extreme cases.

Central orange spot brighter (redder) than in *philodice*.

DISTINCTIVE TRAITS OF THE SEVEN WHITE EURYTHEME FEMALES OF 1943. (UPPER SURFACE ONLY)

All agree in having *large* black discal spots.

(1) Sept. 27 (J. H. G.), Pl. I, fig. 1. Fore-wing border has a complete row of fairly large spots; faintest possible orange flush on inner half of fore and hind wings. Hind-wing border extremely wide, enclosing 4 distinct spots; intensely bright-orange central spots.

(2) Sept. 14 (E. Horton). Fore-wing border wide with large spots. Hind-wing border of intermediate width and only a trace of attendant spotting. Central spots *bright* brick red.

(3) Sept. 18 (E. Horton). Both fore- and hind-wings with wide border marked with large spots. Central spots small, but bright orange.

(4) Sept. 19 (Berry and Blossom), Pl. I, fig. 2. Extremely wide borders of both fore and hind wings; spots of fore-wing border large; central spots bright orange. Faint orange suffusion near inner (posterior) edge of fore-wings. Melanic inner half of fore-wings and whole upper hind-wing surface.

(5) Sept. 19 (L. Chan). Like fig. 3 in width and spots of fore wing borders. Hind wings like fig. 2 but not so melanic. Inner two-thirds of fore-wings have a decided orange flush over the white.

(6) Sept. 19–20 (Jr. Nat. Hist. Club), Pl. I, fig. 3. Fore-wing border wide, with large spots. Indistinct orange flush over fore wings. Hind-wing border moderately wide with two spots near anterior edge. Central spots bright orange.

(7) Sept. 21 (W. Schaldach). Wide, spotted, borders. Melanic. Central spots moderately bright orange.

In my opinion, most observers familiar with *Colias* would probably agree in separating from *philodice* on the basis of color pattern this group of 7 white females. Unfortunately for diagnosis, however, fore- and hind-wing characters do not always coincide. Thus in (2) and in (6, Pl. I, fig. 3) the hind-wing borders are only moderately wide, with a minimum of adjacent spotting. The same is true of some of the white *philodice* pattern-intermediates which follow.

WHITE COLOR-PATTERN INTERMEDIATES CLASSED AS PHILODICE

Six of the 161 white females classed as *philodice* have some but not all of the distinctive color-pattern traits of *eurytheme* mentioned; they appear to me to be *philodice*-like within the limits of its variation in this region. The first one to be described, however, may be an F_1 *eurytheme* × *philodice*. It closely resembles, for example, some of a highly variable 1913 F_1 hybrid brood, and was caught on the same day as a definitely F_1 ♂.

(1) Sept. 12 (J. H. G.), Pl. I, fig. 6. Varies from average *philodice* in size and in respect to the hind-wing border, which is slightly wider than usual, with incipient spotting. Its fore-wing borders are of medium width with small spots; large discal spots. Central spots intermediate orange. Faint greenish suffusion above, over inner half of hind wings, not uncommon in *philodice*.

(2; and 3, Pl. I, fig. 7), Sept. 13 (J. H. G.). Slightly melanic. Fore-wing borders have small, faint spots. Large discal spots. Hind-wing border intermediate, but with adjacent spots on the faintly melanic ground color. Central spots pale, or intermediate, orange.

(4) Sept. 19 (E. Horton). Below normal in size. Rounded fore-wings; large discal spots. Fore-wing border moderately wide with spots of intermediate size. Hind-wing border of intermediate width, with small adjacent spots on melanic background. Large central spots of intermediate orange. Ground color not of the usual dead white but faintly greenish yellow of an unusual tint.

(5) Sept. 18 (Jr. Nat. Hist. Club). Fore-wing border with extremely small spots. Hind-wing border slightly wider than in most *philodice*, with two incipient spots. Central spots pale orange.

(6) Sept. 18. Fore-wing border with small spots. Hind wings slightly melanic, with row of clear spots adjacent to border of intermediate width. (5 and 6 are like Pl. I, figs. 6 and 7, in pattern.) Large, double, fairly bright-orange central spots.

Conclusion as to the six pattern-intermediates: It is evident that the color-pattern of none of them agrees in all respects with *eurytheme's* as I have defined it, but probably lies in each well within the limits of variation in *philodice*, with which they have been listed. Only one of them, (1) Pl. I, fig. 6, shows evidence of possibly being a *philodice* × *eurytheme* hybrid. The small number (3) of pale-orange ♀ hybrids and absence of direct evidence are reasons against counting it as a hybrid. Though most white females can be readily distinguished as *eurytheme* or as *philodice*, others, of intermediate color-pattern, are thus at present difficult to classify with such accuracy as is possible in distinguishing and classifying males and "colored" females as *eurytheme*, *philodice* or hybrid.

WHITE FEMALE PERCENTAGE IN EURYTHEME

The number of white *eurytheme* females caught in 1943 is so small (7 in 42) that its slightly lower percent (16.7 ± 5.7) than that of *philodice* is probably not significant. If three *philodice* white females of "inter-

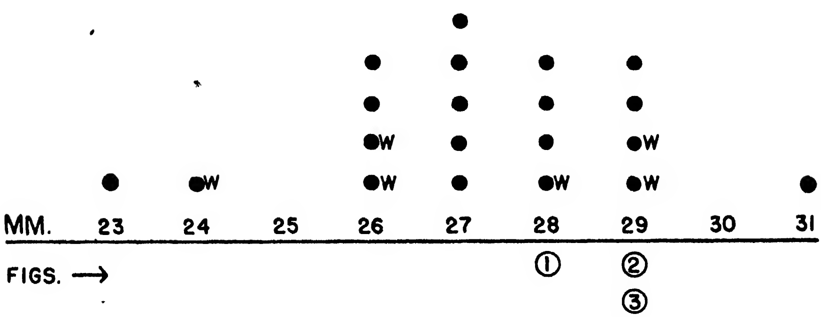
FORE-WING LENGTHS IN MM. OF 20 *C. EURYTHEME* AND OF 20 *C. PHILODICE* FEMALES

(Sept. 13 – Oct. 19, 1943)

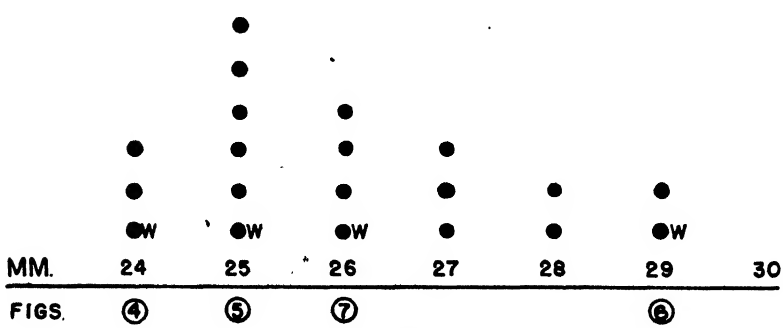
FOR SIZE OF SPECIMENS IN PL. I, FIGS. 1-7, NOTE THEIR POSITIONS BENEATH BASE-LINE.

"W" AT RIGHT OF A MEASUREMENT MEANS WHITE ♀

C. EURYTHEME



C. PHILODICE



mediate" pattern were to be selected and transferred to ***eurytheme***, ***philodice's*** white ♀ percentage would be reduced only to 23.0, while ***eurytheme's*** would be raised to 22.2 (with large probable error) which is virtually the same as that for all whites combined, viz., 22.9. I am unable to select from among the six white "intermediates" here briefly described any three deserving priority for such a hypothetical transfer to ***eurytheme***.

FEMALE SIZE-DIFFERENCES, EURYTHEME AND PHILODICE

The obviously larger size of the white female of intermediate color-pattern of questionable standing (Pl. I, fig. 6) than the other white ♀ ♀ of ***philodice*** shown (Pl. I, figs. 4, 5, 7) suggested measuring the fore-wing length of 20 representative specimens of each species. They were random individuals of this survey suitable for accurate measurements. The graphs shown in Plate II indicate (1) that ♀ ♀ of ***eurytheme*** average larger in fore-wing length than ***philodice***, (2) that those in the natural-size photographs of Plate I (figs. 1–3) are slightly above the average for ***eurytheme***, while those of ***philodice*** shown in Plate I, figs. 4, 5, 7 are slightly below ***philodice's***. The ***philodice*** of intermediate pattern (fig. 6) is seen to be not beyond the range for that species though above its average. It will be noted that if this individual were to be counted as a hybrid (13th) rather than as ***philodice***, the percent of hybrids would become 0.7, rather than 0.65, that of ***philodice*** remaining at 90.7.

SUMMARY OF THE 1943 SURVEY AT HANOVER, WITH DATA ON WHITE FEMALES

	philodice			*eurytheme*			hybrids		
		yellow	white		orange	white		pale-orange	white
	♂	♀	♀	♂	♀	♀	♂	♀	♀
	992	528	161	117	35	7	9	3	0=1852
Total		1681			159			12	=1852
Percent		90.77 ± .68			8.58 ± .66			0.65 ± .18	
Total n		689			42			3	= 734
White ♀ %		23.4 ± 1.6			16.7 ± 5.7				

Percent of all white ♀ ♀ combined = 22.9 ± 1.5 (n = 734).

For the 1943 collection of specimens at Hanover, I am greatly indebted to Mr. Douglas E. Wade, College Naturalist, to Misses Anna Blossom and Ruth Berry, William Schaldach and a number of younger collaborators.

My Dartmouth colleague, Dr. James Franklin Crow, especially deserves thanks for his friendly advice and assistance in presenting the statistical data.

HYBRIDIZATION NEAR WASHINGTON, D. C., AND IN EASTERN CALIFORNIA. A REVIEW

In Clark's (1932) classic work on the Butterflies of the District of Columbia, he describes in considerable detail the advent of ***Colias eurytheme*** into that region, with notes on its relative abundance as

compared with *C. philodice.* "In 1927 it was exceedingly abundant. In the higher and more exposed areas . . . its numbers were equal to more than half the numbers of the yellow clover (*Colias philodice*) when the latter was at its maximum. Indeed, on some days there seemed to be no difference in the frequency of the two species." In 1928: "On October 6 and 7 a careful count was made at Cabin John, and it was found to be just one-fifth as numerous as *C. philodice.*" In 1930: "At the end of the summer it far outnumbered *C. philodice.*" In 1932, again regarding *C. eurytheme*: "Whether it will continue as a permanent resident, or will decrease to its former status as a rather scarce late summer intruder, or will eventually entirely disappear, remains to be seen."

In this memoir (Clark, 1932), differences in color pattern and size between *C. eurytheme* and *C. philodice* are strikingly shown in his excellent plates No. 26 and No. 27. Typical large *eurytheme* females, with very wide black borders enclosing spots of ground color, are seen in Pl. 26, figs. 5, 6, 8. Fig. 3 is a "yellow female with a barely perceptible orange flush," probably a hybrid. Fig. 4 is a typical white *eurytheme* ♀ with large spots in the border; Fig. 8, another white ♀ "flushed with pink on the discal portion of the fore wings and with yellow on the hind wings." These *eurytheme* ♀ ♀ of Pl. 26 are markedly different in color pattern from those of *philodice* shown in Pl. 27, viz., Figs. 5, 6, 7. Fig. 5 has only vestiges of spots on the fore wing border; 6 and 7 are spring forms in which the hind wing border is extremely narrow; 8 is white, lacking spots altogether on the fore-wing border but having a slightly wider hind-wing border than is usual in *philodice.*

No further notes on *Colias* near Washington D. C., published between 1932 and 1941 have come to my attention. During those nine years, however, *eurytheme* appears to have increased in numbers, along with its hybrids, so that, on the basis of "a very large number of specimens" collected by Mr. W. H. Wagner, Jr., Clark (1941) solved his difficulty in distinguishing *eurytheme* and hybrids from *philodice* by writing a "composite description" which "covers all forms between the most extreme *eurytheme* (form *amphidusa*) and the most extreme *philodice,* including the yellow phase or variety of *eurytheme* and *eriphyle.*"

This combination Clark called *C. chrysotheme* Esper after the small Austro-Hungarian orange butterfly which resembles the color phase of *eurytheme* formerly known as "*keewaydin,* W. H. Edw."

This superficial similarity led Hagen (1883) to identify *chrysotheme* with "keewaydin" (i.e., *eurytheme*) though not with *philodice;* and Elwes (1884) in an excellent article on this genus did exactly the same.

It seems to me unfortunate to lump the orange and the yellow "species" of this group, with their local hereditary diversities in morphology and physiology, under the name of a foreign species ranging from Vienna eastward into Siberia, about which, in ignorance of Russian entomological literature, I have been able to get very little information. Certainly no one can tell us whether *chrysotheme* Esper would mate with *eurytheme,* either with or without fertility. Moreover, we are still ignorant of the exact relation of *eurytheme* and *eriphyle* to other western American "species," such as the yellow *chrysomelas* of northern,

barbara of southern, California, and to the legume-feeding "***christina-emilia-alexandra*** complex," an apparently hybrid combination exhibiting orange, yellow, and white-female colors.

Another objection to importing the name *chrysotheme* into America and applying it to *philodice* is that its use as a blanket term may tend to conceal facts about hybridization. Hybrids in a museum, when not recognized as such, become absorbed into a meaningless welter of "forms," and thus hybridization fails to be recognized as of importance in evolution.

Owing to war conditions and absence of collectors, it was not feasible in 1943 to make any quantitative survey of *Colias* near Washington, D. C. On August 31 of that year, Clark wrote me that: "Our *Colias* in this region seem now to have settled down into a stabilized hybrid form with, so far as can be seen superficially, relatively little variation." On September 20, '43, he wrote regarding Mt. Solon in western Virginia: "Here *philodice* is still common—about one-third of the total. All the individuals seen appeared to be pretty uniform, either yellow or orange—or white." Of these he sent me ten specimens to examine, 2 of which were *philodice* ♂♂ and 8 *eurytheme:* 3 ♂♂ + 4 ♂♂ + 1 very large white ♀,—a sample in line with his population estimate for that locality. There was no hybrid intermediate among them. All this refers to the lower mountain levels, whereas "practically the whole population in the higher mountain pastures" was *philodice.* "In the lowlands, conditions are quite different" (letter of September 27, '43). A series of intermediate forms were collected by him in southwestern Virginia, near Covington, similar to that made near Washington by W. Herbert Wagner, both lots of which were distributed through the collection and difficult to segregate. Consequently we must still wait until another favorable season arrives for definite quantitative data on the lowland population near Washington.

However, in the spring of 1945 two small collections were made for me at Charlottesville, Va., by Dr. Carl W. Gottschalk and Miss Sarah E. Roberts, which indicate that typical *eurytheme* (spring form) may have been four times as abundant as *philodice.* No hybrids were taken. There were altogether 25 *eurytheme* and 6 *philodice.* Of *eurytheme*, there were 14 ♂♂ and 12 ♀♀; 2 of these ♀♀ were white. The *philodice* were 3 ♂♂, 1 yellow ♀ and 2 white ♀♀.

Eight others (6 *philodice* and 2 *eurytheme*) from Charlottesville caught in the spring of 1941 included: 4 ♂♂ *philodice,* 1 yellow and 1 white *philodice* ♀, and 2 *eurytheme* ♂♂, but no hybrid.

Another collection of 29 made at Farmville, central Virginia, during the season of 1940 by Mr. Frank Trainer and Dr. Gottschalk, and sent to me by the latter, included the following:

3 *philodice:* 1 ♂, April 27; 1 white ♀, May 9; 1 yellow ♀, Sept. 8.

23 *eurytheme:* 16 ♂♂ (April 6–July 28); 6 orange ♀♀ (May 5–Aug. 18), 1 white ♀, April 29.

3 hybrids: 1 ♀ (pale orange), July 7; 1 ♂, Sept. 7; and 1 ♂, April 6.

The probable hybrid ♂ of April 6 was caught on the same day with seven small, ariadne-like ♂♂ of *eurytheme.* Compared with them, it is of average size. The reduced orange, along the inner

(posterior) edge of the primaries, and correspondingly less brilliant central orange spots are associated with a slightly wider black fore-wing border. On the strength of these slight differences, I regard it as almost certainly a hybrid. Summer hybrids, on the other hand, are very easily detected. The Sept. 7 ♂ is a perfect example of an F_1 hybrid.

Dr. Gottschalk wrote me (March 19, 1946) that the collections were made without "particular reference to species. *Eurytheme* is much more common."

The striking fact, perhaps, is not the increasing abundance of *eurytheme*, but rather the relative rareness of *philodice* in this region where it formerly was found exclusively. The explanation may be that *philodice* continues to use white clover almost exclusively (as first suggested by Hovanitz), while alfalfa is, at least, the preferred food plant of *eurytheme*, though, as I have shown, it lays and grows readily on white clover. That the huge size and intense orange color of "amphidusa" (a summer form of *eurytheme*) can be attained only by growth on alfalfa (and not on white clover) is probable, though not yet proved experimentally.

Eastern California: Under "*chrysotheme*, yellow race," Hovanitz (1943) lumps together the series of diverse geographical races which I have called (Gerould, 1943) the "*eriphyle-philodice* complex," extending from Alberta across the continent to Maine. Presumably derived by ancient mutations from the now highly heterozygous *eurytheme* of the extreme northwest and eastern California, this series in the Rocky Mountains exhibits in the female a succession of variations showing a gradual loss of orange. Eastward from the Rockies, it becomes the clear sulphur-yellow *philodice* of the central and eastern States.

In eastern California Hovanitz (1943) found about 10% of natural hybrids between *eriphyle* and *eurytheme* at a locality where both occur simultaneously (Round Valley, about 50 miles southeast of Yosemite). At a higher elevation 50 miles away (Mono Lake), *eurytheme* occurs continuously throughout the summer but the generations of the rarer *eriphyle* are separated by interbrood periods (as in June) with no adults. No data on hybridization there were published. At Round Valley, however, during two summers when large numbers of both were observed, *eriphyle* was usually slightly in excess (65%) and, as is common in *Colias*, there was a large excess of males. The percentage of hybrids was smallest, 6.08%, when the observed number was greatest, 575, but 10% seems to be a fair average.

Hovanitz notes that the "two races have maintained their primary discreteness" notwithstanding long interbreeding. If hybridization were "only of very recent origin," he would expect a higher frequency of F_1 than of other (backcross) intermediates. This appears from the histogram to be the case only in the male, in which tendency to a trimodal curve is shown, whereas in the female the curve is U-shaped with a hollow where F_1 would be. To explain this "lack of the F_1 intermediates" in the female, "a general lower viability seems to be the most likely."

He kindly sent me for examination from Round Valley, June, 1941, 11 *eurytheme*, 22 *eriphyle*, and 6 hybrid, *males;* also 2 typical *eurytheme*

(one, pale) and 5 ***eriphyle, females,*** but no recognizable ♀ hybrids. Hybridity of the 6 males seems certain, for in pure ***eriphyle*** broods from various localities I have found that the males are constantly clear yellow. Two of the 6 hybrid males were apparently F_1 of ***eurytheme*** × ***eriphyle;*** four were paler, evidently of a backcross to ***eriphyle.***

SUMMARY

Population percentages of bright-orange *Colias eurytheme* Boisduval, plus pale-orange hybrids, in territory long occupied by the clear-yellow *C. philodice* Godart, increased between 1940 and 1943 six-fold, i.e., from 1.5±0.5 percent (n=658) in 1940 to 9.2±0.7% (n=1852) in 1943. Meanwhile, the proportion of hybrids to pure ***eurytheme*** apparently decreased from around 50% (n=10) to 7.0 (n=171). But in 1940 only 1 ***eurytheme*** ♀ was taken (with 4 ♂♂ and 5 hybrid ♂♂). In 1943, however, 42 pure ***eurytheme*** females (5.7% of the whole *Colias* female population-sample examined) were captured, with 117 ***eurytheme*** males, so that these were able to mate within their own species. One such couple was caught; and no cross-mating was observed. (See also Gerould, 1943, p. 408.) In 1945, the foreign *Colias* population (i.e., *eurytheme*+hybrids) observed in a much smaller sample (301) was 24, or 8. %, nearly equal to the 9. % taken in 1943, but the percent of hybrids to pure *eurytheme* had increased to several times the 7. % of 1943, viz., to around 20. %, though only 19 *eurytheme* and 5 hybrids were taken.

However, the percent of hybrids in the whole *Colias* population-sample in 1940 and again in 1943 was less than 1. %; in 1945 it was approximately 1.5%. These figures may be compared with the 10. % of ***eurytheme***×***eriphyle*** hybrids taken by Hovanitz (1943) at one locality in eastern California.

In 1940, 17.2±2.4% (n=244) of captured ***philodice*** females were white, and no white ***eurytheme*** was taken. In 1943, 23.4±1.6% (n=689) of the ***philodice*** females, as determined by the color pattern, were white, and 16.7±5.7% (n=42) of ***eurytheme*** females were white. Combining both species, 22.9±1.5% (n=734) of all females were white. In 1945, the 26 white females taken were all ***philodice,*** i.e., 21.0±3.7% of the 124 ♀♀ taken.

Upper-surface color-pattern differences between the females of ***eurytheme*** and ***philodice*** are described and illustrated. Though most white females can be readily distinguished as ***eurytheme*** or as ***philodice,*** others, of intermediate color-pattern, are difficult to classify with as much accuracy as is possible in distinguishing and classifying the males and "colored" females as ***eurytheme, philodice*** or hybrid. "Colored" hybrids of the backcross to ***eurytheme*** are also difficult to distinguish from members of that "species" of definite purity (homozygosity), so that one is strongly inclined to lump them under one species name.

The use of "*Colias chrysotheme* Esper," however, to cover *C.* ***eurytheme,*** *C.* ***philodice*** and their hybrids is based on slight evidence. It is likely, in my opinion, to confuse, rather than promote, taxonomy and genetics.

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COMMON INSECTS OF HAWAII, by DAVID T. FULLAWAY and NOEL L. H. KRAUSS. 228 pages, 16 text figures, 12 colored plates, 1945. Tongg Publishing Company, Honolulu. Price $3.50.

The work and expense involved in the production of a book illustrated in color should result in a volume worthy of unstinted praise, but this one, unfortunately, leaves the reviewer with mixed impressions. Its purpose is indicated in the preface as just what the title suggests, but with the further statement that "it is definitely not another Fauna Hawaiiensis, but rather a cross-section of the lowland fauna." Further the preface states that many of the common economic insects have been omitted to conserve space. These statements raise a question as to the exact purpose of the book, particularly when its organization is considered.

Passing on to the first chapter one finds an elementary description of insect morphology and metamorphosis. The remainder consists of eight chapters dealing with various orders of insects and a final chapter on arthropods of other orders. Three hundred fifty-seven serially numbered species are considered, the treatment varying from a few lines on habitat, distribution and distinctive characters to more than a page, including life history. No discussion of the classification and no keys are included.

The conclusion is inevitable that the value of the book to the amateur is limited by the omission of aids to identification and for the trained entomologist who does not need such aids its scope seems also a limitation. With colored illustrations it may be a valuable aid to quick identification of many species, but here again a limitation is encountered in the quality of the plates. Evidently the original drawings were excellent and the four-color process used in reproduction should have been adequate, but in the reviewer's copy the several impressions are out of register on most of the plates and on some to a degree which is very trying to the eyes. It is unfortunate that the printers failed to do justice to their copy.

The reviewer is not familiar with the Hawaiian fauna, hence he can only guess that closely related species whose separation is difficult are not numerous. If this is the case, the book may well serve as a helpful manual within its avowed scope.—A. W. L.

NORTH AMERICAN SPECIES OF THE GENUS HOPLISMENUS[1]
(Hymenoptera: Ichneumonidae)

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This paper includes the species of *Hoplismenus* occurring in the United States and Canada. Seven species are here recognized, three of which are new. Three additional forms, one new, are given subspecific rank.

Material for this study was obtained from the following collections: United States National Museum (US), Academy of Natural Sciences of Philadelphia (ANSP), Cornell University (CU), Oregon State College (Ore), University of Minnesota, Canadian National Collection (CNC), The Iowa Insect Survey Collection, The Townes Collection (Tow), the collection of R. T. Mitchell, and the collection of the author (Sw). The abbreviations after the names above are those used in the following pages. To the various persons in charge of the collections who generously supplied material the writer expresses his appreciation.

Genus **Hoplismenus** Gravenhorst

Hoplismenus Gravenhorst, Ichneum. Europeae, 1829, 2: 409.

Genotype: (*Hoplismenus maestus* Gravenhorst) = *armatorious* Panzer.

Scutellum usually strongly convex; propodeum with a pair of prominent dorsolateral spines; second abdominal tergite heavily punctured, polished or mat; gastrocoeli transverse, 0.2 to 0.4 the width of the abdomen, depressed, the depressed portion sculptured; postpetiole rugulose, irregularly striate or punctate, its surface either polished or mat; temples viewed from above receding, straight or moderately curved; clypeus typically convex, punctate and rather narrow, but in *propitius* and *teres* flattened, polished and rather broad; legs and antennae long and slender, the latter attenuate at apex, the first flagellar segment in the female at least four times as long as broad. A general idea of the habitus of the genus may be gained from Figure 1.

Gravenhorst proposed the genus *Hoplismenus* to include those species with an elevated scutellum, two propodeal spines, and oblong, petiolate abdomen, pentangular areolet, and slender legs and antennae. Because of superficial similarities several Platylabini have been assigned to *Hoplismenus* in the past. Cresson[2] first recognized the genus in this country as represented by *morulus* (Say).

The generic limits of *Hoplismenus* are not completely defined, and the inclusion here of *scutellatus*, *propitius*, and *teres* may be open to

[1]The writer wishes to express his appreciation to Dr. Henry K. Townes for the assistance generously given during the preparation of this paper.

[2]Cresson, E. T. 1868. *Trans. Amer. Ent. Soc.*, 2: 89.

question. The final decision as to generic boundaries must await more careful study, particularly of the many species of *Hoplismenus* and related genera in the tropical fauna. The genus *Peritaenius* Förster is applied by Clément to those species of *Hoplismenus* with the scutellum transversely carinate at the apex.[3] If this genus is valid, *scutellatus* apparently should be assigned to it. None of the species placed in *Peritaenius* by Clément, however, have been seen by the author, and in the absence of definite evidence it seems best to keep *scutellatus* in *Hoplismenus*. There is much variation in the scutellum among the species of *Hoplismenus* and related genera. The transversely carinate scutellum exists in varying degrees of prominence from the weakly tectiform shape present in the European *perniciosus* Grav. to the strongly margined scutellum of *scutellatus*. Its importance as a primary generic character thus appears doubtful.

Largely because of its flat, expanded clypeus and weakly convex scutellum *propitius* has not been included in *Hoplismenus* in the past. But *propitius*, and hence also *teres*, is more closely related to typical *Hoplismenus* than to any other genus known to the author, and does not seem distinct enough to warrant the erection of a new genus.

Kreichbaumer,[4] Schmeideknecht,[5] and Townes[6] have considered the genus *Rhysaspis* Tischbein a synonym of *Hoplismenus*. Clément[7] considers *Rhysaspis* distinct, containing the European species *rugosus* Tisch. and *kreichbaumeri* Clement. Neither of these species is available to the author for study, and thus the synonymy cannot be reviewed at this time. Heinrich[8] states that the genotype of *Xanthojoppa* Cameron, *X. nigrolineata* Cam., belongs in *Hoplismenus*. Specimens of this species have not been seen by the author and the synonymy of *Xanthojoppa* with *Hoplismenus* cannot be confirmed here.

The genus *Hoplismenus* is world wide in distribution. Schmiedeknecht[9] lists 10 species for Europe and Uchida[10] lists 8 as occurring in Japan. Della Torre in his *Catalogus Hymenopterorum* mentions 35 species as placed in *Hoplismenus* up to 1901,[11] and about that number of additional species have been described since then. Several of these are undoubtedly misplaced Platylabini or species belonging to other amblyteline genera. The author has seen about 20 species of *Hoplismenus*, for the most part undescribed, from Central and South America, Africa, and China.

All North American host records are in the Nymphalidae. Other records belong predominantly in that family but also in the Pieridae, Phalaenidae, and possibly others. In all cases known to the writer the adult parasite emerges from the host chrysalis.

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[3]Clément, Von E. 1927. *Konowia*, 6: 74.
[4]Kreichbaumer, J. 1894. *Entom. Nachrichten*, p. 347.
[5]Schmeideknecht, O. 1903. *Opuscula Ichneumonologica*, Blankenburg, p. 202.
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[8]Heinrich, G. 1933. *Mitt. Zool. Mus. Berlin*, 19: 164.
[9]Schmeideknecht, O. *Op. cit.*, p. 202.
[10]Uchida, T. 1926. *Journ. Coll. Agri. Hokkaido Imperial Univ.*, Sapporo, Japan, 18: 68.
[11]Dalla Torre, K. 1901. *Catalogus Hymenopterorum*, Leipzig, 3: 1024.

A KEY TO THE NEARCTIC SPECIES OF HOPLISMENUS

1. Thorax and abdomen black except for occasional marks on scutellum, subtegular ridge,[12] and apices of abdominal tergites; wings blackish; face and clypeus strongly punctate......................(1. **morulus**) 2
   Thorax or abdomen at least in part ferruginous or reddish; wings hyaline or subhyaline..4
2. Hind femur ferruginous to stramineous. (California, Oregon, Washington, and British Columbia)......................1b. **morulus pacificus**
   Hind femur black or blackish, occasionally pale at apex..................3
3. Hind tibia yellowish. (Eastern and central United States and Canada), 1a. **morulus morulus**
   Hind tibia at least in part black or blackish. (Colorado, Utah, and New Mexico)..1c. **morulus flavitarsis**
4. Scutellum elevated apically into a subacute, transverse carina; propodeal carinae regular and well marked; tarsi yellowish white.......3. **scutellatus**
   Scutellum rounded, without an apical, subacute transverse carina...........5
5. Thorax black. (Figure 1)..............................2. **arizonensis**
   Thorax mostly reddish...6
6. Clypeus convex, opaque, and strongly punctate; second abdominal tergite not piceous at apex...7
   Clypeus flat or very weakly convex, polished, impunctate or very weakly punctate; second abdominal tergite more or less piceous at apex...........9
7. Eye margined with white posteriorly; postpetiole as closely punctate as the second tergite (Figure 6); mesoplerum opaque, closely punctate, the punctures nowhere separated by their own width.............5. **praeruptus**
   Eye not margined with white posteriorly; postpetiole mat, with a few scattered punctures, never as closely punctate as the second tergite (Figure 7); mesopleurum polished, the punctures separated in some areas by at least their own width....................................(4. **rutilus**) 8
8. Antennal annulus usually on flagellar segments 6 to 11; hind basitarsus more or less piceous, the remaining tarsal joints yellowish. (Northeastern United States)...............................4a. **rutilus rutilus**
   Antennal annulus only on flagellar segments 8 to 10; hind tarsus with the second joint usually piceous as the first, the apical joints more or less ferruginous. (Colorado, Wyoming, and Oregon).........4b. **rutilus tenuis**
9. Clypeus with the lateral margins parallel, the apical corners approaching right angles, the apical margin often slightly reflexed (Figures 4 and 5); male with tyloids[13] broad and distinct; female with cheeks on anterior view distinctly convex....................................6. **propitius**
   Clypeus with the lateral margins converging, the apical corners broadly rounded (Figures 2 and 3); male with tyloids linear, often indistinct; female with cheeks on anterior view very weakly convex..........7. **teres**

1. Hoplismenus morulus (Say)

Three nearctic subspecies are considered here under *morulus*. The form *morulus* represents the species in the eastern and central United States and Canada, the westernmost records being Colorado and Alberta; *flavitarsis* occurs in Colorado, Utah, and New Mexico, and *pacificus* in California, Oregon, Washington, and British Columbia. No differences in structure between these forms were found, and they thus seem to constitute one polytypic species. No specimens have been seen that could be considered as intergrades.

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[12]The term *subtegular ridge*, as used here and in the following pages, refers to the sharp ridge that projects laterally from the dorsal margin of the mesopleurum immediately below the tegula.

[13]The term *tyloids* as used here applies to elongate, raised and polished areas on the posterolateral face of the male flagellum. They occur on each of several median and postmedian segments.

It is interesting to note that the difference in color pattern between the subspecies *morulus* and *pacificus*, namely, the change from yellow and black leg color to dull reddish or piceous, is paralleled by a few other ichneumons not necessarily closely related. For example, in the northwestern race of *Exetastes bituminosus* Cush. the legs are darker than in the east and the antennal annulus, present in eastern specimens, is lacking. In *Rhembobius abdominalis* (Prov.) the eastern form with red and black hind legs is replaced in the west by a race in which the hind legs are an even dull reddish.

The concept of *Hoplismenus morulus* should possibly be expanded to include non-nearctic subspecies. The author has seen two specimens of *Hoplismenus terrificus* Wesmael from Switzerland in the United States National Museum. This form is extremely close to *morulus* although more specimens must be examined before *terrificus* can definitely be considered as another subspecies. *H. lamprolabus* Wesmael, a closely related European form, is a distinct species, differentiated by shorter antennae, smaller gastrocoeli, more polished abdominal tergites, and a larger scutellum.

1a. Hoplismenus morulus morulus (Say)

Ichneumon morulus Say, Contrib. Maclurean Lyceum Arts Sci., 1829, 1: 73 (Leconte Ed., 1:377), female.
Hoplismenus morulus Cresson, Trans. Amer. Ent. Soc., 1868, 2: 89.
Ichneumon calacratus Provancher, Nat. Canad., 1875, 7: 21, 49, male.
Hoplismenus morulus Cresson, Trans. Amer. Ent. Soc., 1877, 6: 186, male, female.
Hoplismenus morulus Provancher, Nat. Canad., 1879, 11: 2 (Faunae, p. 291).
Hoplismenus morulus var. *morulus* Townes, Mem. Amer. Ent. Soc., 1944, 11: 319.

Only the more important taxonomic references are listed here. For a complete bibliography of the species the reader is referred to the last reference given above.

Female.—Length 11–18 mm. Black except as follows: all tibiae and tarsi, often apices of the femora, and usually the inside margin of the eye deep yellowish; antennal annulus white or light yellow, beginning on flagellar segments 5 to 7 and ending on segments 13 to 16; femora, flagellar segments, and apices of abdominal tergites occasionally dark reddish or dark stramineous; wings blackish.

Clypeus punctate, polished, truncate or slightly rounded at the apex, strongly convex, viewed from the side meeting the labrum in approximately a right angle; face strongly punctate, more or less mat, elongate, with a median swelling that is continuous on to the clypeus; temples viewed from above strongly receding, the sides straight; occipital carina prominent; thorax coarsely punctate, more or less mat, the mesoscutum often rugose in the region of the notaulus; scutellum punctate, polished, subpyramidal; propodeum with many large, irregular rugae and a pair of prominent dorsolateral spines; propodeal carinae irregular but usually distinct; petiole square in cross section, the dorsal surface smooth and polished, the lateral and ventral surfaces with large, regular, transverse rugae; postpetiole polished, rugulose, occasionally with a few scattered punctures; gastrocoelus impressed, 0.3 to 0.4 the width of the abdomen; second abdominal tergite strongly punctate, weakly mat; legs long and slender; antenna slender, attenuate

at the apex, the first flagellar segment slightly more than four times as long as broad at base.

Male.—Black except as follows: face and clypeus, except occasionally for median dark markings, scape below, usually a mark on the scutellum and subtegular ridge light yellow; flagellar segments below, all tibiae and tarsi, front femur, all or most of middle femur, apex of hind femur, and all or some of the front and middle trochanters deep yellowish; wings blackish.

Structure similar to the female except as follows: clypeus somewhat less convex; first flagellar segment about three times as long as broad at base; tyloids elongate-oval, beginning on flagellar segments 7 to 9, ending on segments 19 to 21.

The type of *morulus* has been destroyed; the type of *calcaratus* is in the Museum of the Province of Quebec, at Quebec.

Material: 147 females and 20 males from Massachusetts (Cambridge); Connecticut; New York (Ithaca, Bemus Point); New Jersey (Moorestown); Pennsylvania (Valley Forge, North Cumberland, Linglestown, Roberts P. O.); Maryland (Bowie, Plummers Island); Ohio (Champaign Co., Put-in-Bay); Indiana (Elkhart); West Virginia (Bolivar); Virginia (near Plummers Island); north Illinois; Michigan (Ann Arbor); Wisconsin (Sawyer Co.); Minnesota (Dakota Co., Rice Co., Hennepin Co., Mille Lacs Co., Case Co., St. Peter, Garrison, Itasca Park, Mille Lacs Lake); Iowa (Louisa Co., Jefferson Co., Henry Co., Des Moines Co., Linn Co., Crawford Co., Mt. Vernon, Iowa City, Coralville, Davenport, Mt. Pleasant, Anamosa, Ames); Kansas (Onaga); Prince Edward Island (Brackley Beach in the Canadian National Park); Ontario (Ottawa, Toronto, Orillia Co., Hastings, Georgetown, Constance Bay, Point Pelee); Quebec (Queens Park in Alymer, Hull, Meach Lake, Kingsmere, Covey Hill). Additional records in literature are from Maine, Colorado, and Bilby, Alberta.

This subspecies has been reared from *Nymphalis antiopa* (L.) (the mourning cloak butterfly),[14] and also from *Polygonia interrogationis* (Fab.) (the question mark).[15] Included in the material at hand are two specimens reared from *Vanessa* sp. presumably *cardui* (L.) (the painted lady).[16] One of these, a male, bears the label "Ithaca, N. Y., VIII-16-1885" (CU); the other, a female, was reared by R. T. Mitchell at Bowie, Md., X-9-1944 (Sw.). According to Schaffner and Griswold, *morulus* has two or more generations a year.

This is a species of mesic woods, particularly common along wooded streams and river margins where there is a leafy urticaceous undergrowth. Regions abundant in such plants as *Pilea* (clearweed) and *Laportea* (nettles), upon which the host caterpillars feed, will frequently yield specimens. The greater part of the material examined was collected in the summer months, but *morulus* has been taken in every month of the year.

This subspecies may be readily distinguished in eastern North America by the characters of the species, namely the large, all black

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[14] Howard *in* Scudder. 1889. *Butterflies of Eastern U. S. and Canada*, 3: 1878.

[15] Schaffner and Griswold. 1934. *Misc. Pub. U. S. Dept. Agr.*, 188: 141.

[16] The author is indebted to Mr. Carl Heinrich of the United States National Museum for this determinalion.

body, blackish wings, and peculiarly elongated face. It may be distinguished from the two subspecies that replace it in western North America by the deep yellow hind tibia. In *pacificus* the hind tibia is reddish at the base and often piceous at the apex; in *flavitarsis* the hind tibia is at least in part blackish or piceous.

1b. Hoplismenus morulus flavitarsis (Cresson)

Trogus flavitarsis Cresson, Proc. Ent. Soc. Phila., 1865, 4: 265, male.
Hoplismenus flavitarsis Cresson, Trans. Amer. Ent. Soc., 1868, 2: 89.
Hoplismenus flavitarsis Cresson, Trans. Amer. Ent. Soc., 1877, 6: 185.
Hoplismenus morulus var. *flavitarsis* Viereck, Trans. Amer., Ent. Soc., 1903, 29, 75.
Hoplismenus morulus var. *flavitarsis* Townes, Mem. Amer. Ent. Soc., 1944, 11: 320.

Female.—Black except as follows: front and middle tibiae, all tarsi, and occasionally a stripe on anterior margin of hind tibia deep yellowish; other parts of legs black to more or less dark reddish or dark stramineous; middle tibia and hind basitarsus sometimes dark; a light yellow to white annulus on flagellar segments 6 or 7 to 12 or 13.

Structure as in *morulus morulus.*

Male.—Black except as follows: face and clypeus, except for small median dark markings, and a mark on the scape below white; all tarsi, front and middle tibiae, and front femur at apex light yellow; front and middle femora, and hind tibia stramineous piceous, the hind tibia with a light stripe on the anterior face; apices of abdominal tergites dark reddish; flagellum deep yellowish below.

Structure as in *morulus morulus.*

The description of the male above was taken from the type in the Academy of Natural Sciences of Philadelphia.

Material: 8 females and 1 male. Three females, Colorado (US); 2 females, Colorado (ANSP); male, *type,* Colorado (ANSP); female, Garden of the Gods, Colorado (US); female, Beulah, New Mexico, VIII-17-1901, H. Skinner (ANSP); female, Farmington, Utah, "June-July" 1944, G. S. Bohart (Tow).

1c. Hoplismenus morulus pacificus Cresson

Hoplismenus pacificus Cresson, Trans. Amer. Ent. Soc., 1877, 6: 186, male, female.
Hoplismenus pacificus Cresson, Proc. Acad. Nat. Sci. Phila., 1878, p. 354.
Hoplismenus pacificus Townes, Mem. Amer. Ent. Soc., 1944, 11: 320.

Female.—Black except as follows: all legs including coxae, the scape below, occasional marks on clypeus and lateral margins of face ferruginous; apical end of hind tibia, and often the basal half of hind basitarsus dark reddish to piceous; apical 4 joints of hind tarsus occasionally light yellow; a light yellow to white annulus beginning on flagellar segments 5 to 7, ending on segments 11 to 13; apical antennal

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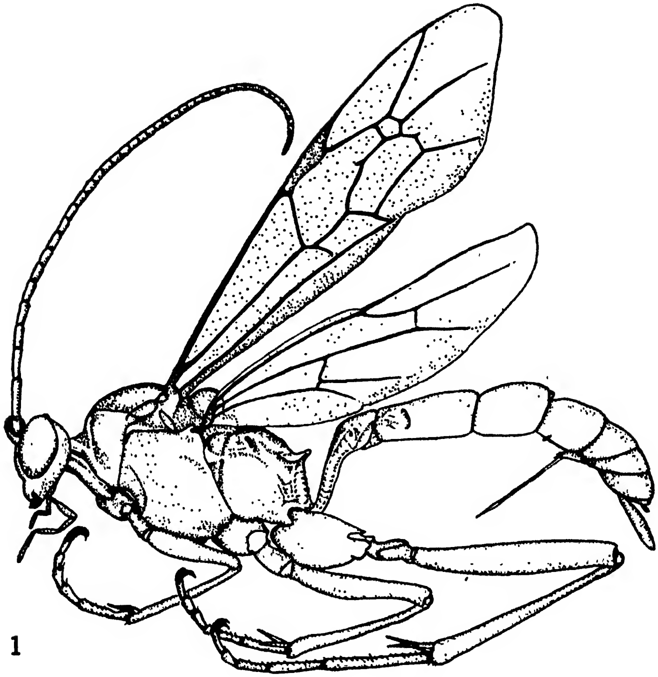
EXPLANATION OF PLATE

1. *Hoplismenus arizonensis.* 2. *Hoplismenus teres,* male. 3. *Hoplismenus teres,* female. 4. *Hoplismenus propitius,* male. 5. *Hoplismenus propitius,* female. 6. *Hoplismenus praeruptus,* postpetiole, dorsal view. 7. *Hoplismenus rutilus,* postpetiole, dorsal view. 8. *Hoplismenus praeruptus,* scutellum, lateral view. 9. *Hoplismenus rutilis,* scutellum, lateral view.



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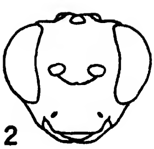

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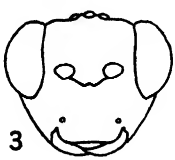

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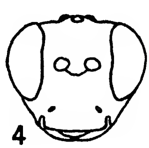

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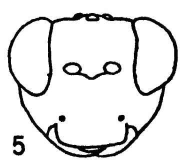

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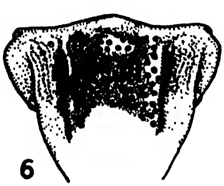

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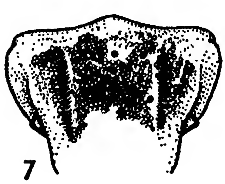

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segments often lighter below; apices of abdominal tergites occasionally dark reddish.

Structure as in ***morulus morulus***.

Male.—Black except as follows: face, clypeus, and the scape below variously marked with black, ferruginous, and light yellowish or white; flagellar segments below often dull yellowish; all legs, including the coxae, ferruginous to yellowish, with the coxae, trochanters, and apex of the hind tibia often marked with piceous; abdominal tergites, particularly at the apices, occasionally dark reddish or dark stramineous.

Structure as in ***morulus morulus***.

The type, a female from Vancouver Island, British Columbia, is in the Academy of Natural Sciences of Philadelphia.

Material: 38 females and 7 males from California (Guerneville in Sonoma Co., Mesa Grande in Sonoma Co., Fort Seward, Blocksburg); Oregon (Vida, Portland, Gold Beach, 2 miles west of Paulina Lake); Washington (Forks in Clallam Co., North Bend in King Co., Elbe, Pullman, Hamma Hamma, Easton, Tieton); British Columbia (Robson, Wellington, Nanaimo, Victoria, Oliver, Agassiz, Clinton, Osoyoos, Vancouver, Kaslo, Field Rocky Mountains at 4800 feet).

Included in the material at hand are two females reared from *Nymphalis californica* (Bdv.) (the California tortoise-shell). They are labeled "Hamma Hamma, Wn., VI–27–1935, ex Aglais californica, R. L. Furniss, Hopk., US 31,650-B" (US).

2. **Hoplismenus arizonensis** n. sp.

Female.—(Figure 1). Length 13 mm. Head and thorax black except as follows: lateral margins of face, a mark on the anterior margin of pronotum, a small spot on the subtegular ridge, and a mark on the scutellum yellowish white; legs and abdomen uniformly reddish except as follows: front and middle coxae and trochanters, and the petiole at base faintly marked with piceous; front tibia with a pale stripe on the anterior margin; ovipositor sheath reddish, the apex black; antenna black, a pale annulus on flagellar segments 8 to 14; wings subhyaline, veins dark brown, a pale spot at base of stigma.

Face and clypeus heavily punctured, the clypeus strongly convex, weakly mat; temples viewed from above straight, strongly receding, on lateral view only half as wide as the eyes, scutellum polished, heavily punctured, less elevated than in ***morulus***, carinate to middle, the sides almost vertical; propodeum rugose, the carinae weak in the region of the areola, the petiolar area wide; propodeal spines long and narrow; petiole above punctate toward apex; postpetiole polished, rugulose punctate; gastrocoelus about 0.3 the width of the abdomen; second and third tergites heavily punctured, mat.

Male.—Unknown.

Known only from the type specimen, which bears the label "Santa Catalina Mts., Arizona, VI–30, M. Cazier." It is in the United States National Museum.

H. arizonensis and ***scutellatus*** can be distinguished from the other forms described here by the all or largely reddish abdomen. ***H. arizonensis*** differs from ***scutellatus*** in the evenly convex scutellum, not

transversely carinate, the weakly carinate propodeum, narrow propodeal spines, and in the closely punctate, opaque episternum and metapleurum.

3. Hoplismenus scutellatus (Provancher)

Ichneumon scutellatus Provancher, Nat. Canad., 1875, 7: 24, 78, male, female.
Hoplismenus scutellatus Cresson, Trans. Amer. Ent. Soc., 1877, 6: 186, male.
Hoplismenus scutellatus Provancher, Nat. Canad., 1879, 11: 3, (Faune, p. 291).
Hoplismenus transversus Davis, Trans. Amer. Ent. Soc., 1898, 24: 351, male.
Hoplismenus scutellatus Townes, Mem. Amer. Ent. Soc., 1944, 11: 321.

Male.—Length 10 mm. Head black except as follows: face, clypeus, and the margin of cheek behind the eye white; thorax black or piceous, the mesoscutum black or marked with reddish; a mark on the subtegular ridge, a mark on the posterior pronotal margin near tegula, anterior margin of pronotum, and a mark on the scutellum white; tegula white or piceous; abdominal tergites 1 to 3 reddish, the remainder reddish or black; all tarsi, front and middle tibiae, anterior margin of front and middle femora, and marks on front and middle coxae yellowish white; all coxae, hind trochanter, tibia and basitarsus marked with piceous; the remaining parts of legs ferruginous; antenna dark above, deep yellowish below; wings hyaline.

Temples viewed from above rather strongly receding, weakly curved; episternum and metapleurum polished, punctate; scutellum with the lateral carinae extending to the middle, continuous with an apical transverse carina; posterior face of scutellum also bordered by carinae, the sides nearly vertical; propodeum with strong, regular carinae, the petiolar area concave, weakly transversely rugose, polished; postpetiole weakly mat, with a few scattered punctures; gastrocoelus 0.3 the width of the abdomen; second and third abdominal tergites punctate-mat.

Female.—Provancher, in the original description, states that the female is colored exactly as the male except for the antennae.

The type of *scutellatus* is in the Museum of the Province of Quebec, at Quebec. The type of *transversus* is in the Academy of Natural Sciences of Philadelphia.

The above description was taken from two males, both in the Academy of Natural Sciences of Philadelphia. One, the type of *transversus*, Moscow, Idaho, J. M. Aldrich, has an all red abdomen and partially reddish thorax. The other is a much battered specimen, bearing only the label "Càn," probably sent to Cresson by Provancher from the original type series. This specimen has a black thorax and abdominal tergites 4 to the apex black. In spite of the difference in color the author agrees with Townes that *transversus* and *scutellatus* are synonymous.

This is a rare species, apparently represented only by the type material of Provancher, two males and one female, and the male type of *transversus*.

4. Hoplismensus rutilus (Cresson)

Under *rutilus* two subspecies are included. In the material studied the form *rutilus rutilus* is represented from the northeastern United

States. The subspecies *rutilus tenuis* is represented from Colorado, Oregon and Wyoming.

4a. Hoplismenus rutilus rutilus (Cresson)

Ichneumon rutilus Cresson, Proc. Ent. Soc. Phila., 1864, 3: 169, female.
Ichneumon? rutilus Cresson, Trans. Amer. Ent. Soc., 1877, 6: 185, female.
Hoplismenus rutilus Johnson, Biol. Surv. Mt. Desert Region, 1927, 1: 146.
Hoplismenus rutilus Cushman, Proc. U. S. Nat. Mus., 1933, 82: 1.
Hoplismenus rutilus Townes, Mem. Amer. Ent. Soc., 1944, 11: 321 (in part).

Female.—(Figures 7 and 9). Length 10 to 12 mm. Ferruginous except as follows: clypeus, marks on posterior surface of head, pronotum, lateral cervicals, prepectus, region between the scutellum and wing bases, parts of the mesosternum, metapleurum and metasternum often more or less black or piceous; lateral margins of face, anterior margin of pronotum, a mark on the posterior pronotal margin near tegula, subtegular ridge, scutellum, and occasionally the propodeal spines more or less white or light yellow; legs ferruginous except as follows: 4 apical segments of hind tarsus, and a stripe on the anterior face of front tibia usually yellowish; hind basitarsus and apical third of hind tibia piceous; scape ferruginous, occasionally black above; first 5 flagellar segments ferruginous variously marked with black at apex above; antennal annulus usually on flagellar segments 6 to 11; wings faintly brownish yellow, the veins light brown or brown.

Clypeus convex, punctate, opaque; temples viewed from above almost straight; eye 1.1 to 1.4 as wide as cheek[17] malar space 1.6 to 1.8 mandible width at base; mesopleurum polished, the punctures in some regions separated by at least their own width; scutellum polished, weakly punctate, evenly convex on lateral view; metapleural carina distinct, usually complete; postpetiole mat, weakly punctate, never as closely punctate as the second tergite, usually with less than 30 punctures in the median area posterior to the spiracles; gastrocoelus about 0.3 the width of abdomen.

Male.—Unknown. Males of *H. teres* have previously been assigned to this species.

The type, labeled only "Va.," is in the Academy of Natural Sciences of Philadelphia.

Material: 5 females. Winchendon, Massachusetts, VII–1–1892 (Sw); Westerly, Rhode Island, VII–5–1936, M. Chapman (Tow); Lyme, Connecticut, VI–18–1918, Wm. Middleton (US); Wilawana, Pennsylvania, VII–12–1938, R. N. Crandall (Tow); type, Virginia (ANSP).

Three species have previously been confused in collections under *rutilus*. The females placed under *rutilus* in the past are here divided into *rutilus* and *praeruptus*, and the males are placed in *teres*.

H. rutilus is rare and poorly represented in collections. This and the following species are differentiated as the only predominantly red members of the genus in the nearctic region with a convex, punctate and opaque clypeus. The species is close to *praeruptus* but is readily distinguished by the characters listed under that species.

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[17]This ratio was measured from a lateral view, across the greatest width of the eye, perpendicular to the posterior eye margin.

4b. **Hoplismenus rutilus tenuis** n. subsp.

Female.—Differs from *rutilus rutilus* only as follows: size smaller, length 7 to 10 mm.; antennal annulus on flagellar segments 8 to 10 only, usually incomplete; hind tarsus ferruginous, the basitarsus and subsequent joints more or less piceous; light areas reduced or wanting, the light lateral margin of the face reduced to a small spot above the level of the antenna, the light mark on the scutellum wanting except in the Wyoming specimen which has a small light spot in the center; black or piceous areas reduced or wanting, the clypeus, lateral cervicals, and pronotum ferruginous. Wing and vein color as in *rutilus rutilus* except for the Woming specimen, which has wings slightly more hyaline and the veins dark brown.

Male.—Unknown.

The type is deposited in the United States National Museum.

Material: 5 females. *Type*, Twin Sisters, Colorado, "Canadian Zone," VII–23, C. K. W. (US). *Paratypes*, Gregory Canyon, Boulder, Colorado, VIII–2–1916, L. O. Jackson (Sw); Corvallis, Oregon, V–10–1929 (Ore); Corvallis, Oregon (US); Grand Teton National Park, Wyoming, VII–14–1939 (Tow).

5. **Hoplismenus praeruptus** n. sp.

Female.—(Figures 6 and 8). Length 9 to 11 mm. Color as in *rutilus* except as follows: clypeus ferruginous; eye margined with white posteriorly; scutellum with a light mark only in center; hind tarsus entirely ferruginous; fore coxa white in front, the middle coxa with a small white spot; flagellar segments below the annulus uniformly black or piceous; wings faintly brownish, the veins dark brown.

Similar in structure to *rutilus* except as follows: eye 1.5 to 1.6 as wide as cheek; malar space 1.2 to 1.4 mandible width at base; mesopleurum closely punctate, opaque, the punctures nowhere separated by their own width; scutellum elevated, cuboidal; metapleural carina poorly defined, incomplete; postpetiole closely punctate, as much so as the second tergite.

Male.—Unknown.

The type is in the United States National Museum.

Material: 6 females. *Type*, Six Mile Creek, Ithaca, New York, IX–16–1939, P. P. Baiby (US). *Paratypes*, Ithaca, New York, V–9–1936, H. K. Townes (Tow); Connecticut (Sw); Olympia, Washington (US); "13–5," W. H. Harrington Collection (CNC); F. P. Atkinson (ANSP).

The Townes specimen was also taken in the type locality, Six Mile Creek, Ithaca, New York. This is a moist, wooded stream bed area, similar to the habitat preferred by *morulus morulus*.

6. **Hoplismenus propitius** (Cresson)

Ichneumon propitius **Cresson, Trans. Amer. Ent. Soc., 1872, 4: 156, male.**
Ichneumon propitius **Cresson, Trans. Amer. Ent. Soc., 1877, 6: 182.**
Ichneumon tharotis **Packard, Proc. Boston Soc. Nat. Hist., 1881, 21: 22, female.**
Ichneumon instabilis **Howard, *in* Scudder, Butterflies of Eastern U. S. and Canada, 1889, 3: 1876 (misdetermined in part).**
Amblyteles propitius **Cushman, Proc. U. S. Nat. Mus., 1933, 82: 1.**

Amblyteles propitius Schaffner and Griswold, Misc. Pub. U. S. Dept. Agr., 1934, 188: 139.
Amblyteles propitius Brimley, Insects of North Carolina, 1938, p. 405.
Hoplismenus propitius Townes, Mem. Amer. Ent. Soc., 1944, 11: 320.

Female.—(Figure 5). Length 8 to 11 mm. Ferruginous except as follows: parts of the lateral cervical and prepectus, region between the scutellum and wing bases, occasionally the pleural and mesonotal sutures, often parts of the metapleurum and metasternum, and the petiolar tergite and sternite at base piceous or black; sutures of abdominal tergites, hind tarsus, and apices of hind femur and tibia more or less infuscated; scutellum and a mark on the subtegular ridge usually yellow; antenna darker above, ferruginous below, a pale annulus usually on flagellar segments 6 or 7 to 12; wings very slightly dusky, veins brown, the stigma with a pale spot at base. An occasional specimen may be almost completely ferruginous.

Face weakly punctate, weakly mat; clypeus expanded, polished, usually impunctate, the apical margin usually weakly rounded and slightly reflexed; sides of clypeus parallel, making approximately a right angle with the apical margin; mandibles strap-like, not twisted, the smaller tooth arising not or very slightly dorsad of the larger, often expanded near the apex, the shorter tooth usually as wide or wider than the longer at base, the teeth unequal in length by a distance approximately the width of the longer at base; cheeks viewed from in front slightly curved in outline; temples viewed from above moderately receding, rounded; scutellum moderately convex, low for the genus, polished and punctate; propodeal spiracles short oval to oval; propodeal spines short; postpetiole polished, often with a few punctures, usually weakly longitudinally striate, but occasionally finely rugulose; gastrocoelus strongly impressed, rugose, about 0.3 the width of the abdomen; second and third tergites strongly punctured, usually polished except at the apices which are weakly mat.

Male.—(Figure 4). Similar to the female except as follows: face, clypeus, the scape below, portions of front and middle trochanters, hind tibia at base, basal three joints of middle and hind tarsi, anterior margin of pronotum, and a spot on the subtegular ridge yellow or yellowish; antenna yellowish below, dark above, a yellow annulus on flagellar segments 8 to 17. The black region on one specimen includes most of the metasternum and parts of the pronotum and propodeum.

Eye 1.0 to 1.1 as wide as cheek; tyloids well marked, broadly oval.

The type of *propitius* is a male from Bosque County, Texas, now in the United States National Museum. *H. propitius* has been synonymized with *Ichneumon tharotis* Packard by Townes on the basis of a specimen not designated as the type but considered by him to be so. It is labeled "From Dr. Packard, M. tharos 3, Through C. V. Riley, Figure 4 Emerton" and is now in the National Museum type collection.

Material: 12 females and 12 males. Two males and one female, Lynnfield, Massachusetts, VI-24-1931 (US); female, Deering, New Hampshire, VII-11-1923 (US); female, Hampton, New Hampshire, VIII-5-1917, S. Albert Shaw (US); female, Ithaca, New York, VI-25-1890 (US); male, Ithaca, New York, VII-12-1938, "light"

(Tow); female, Long Beach, Long Island, New York, VIII–2–1925, "washup," F. M. Schott (US); female, Champaign Co., Illinois, M. W. Shackleford (US); male, Bowie, Maryland, XI–17–1945, H. H. Swift (Sw); female, Takoma Park, Maryland, VII–29–1943, H. and M. Townes (Tow); 2 males, Takoma Park, Maryland, X–17–1945, H. and M. Townes (Tow); 2 males, Takoma Park, Maryland, X–20–1945, H. and M. Townes (Tow); female, Takoma Park, Maryland, X–21–1945, H. H. Swift (Sw); female, Takoma Park, Maryland, X–21–1945, H. and M. Townes (Tow); female, Takoma Park, Maryland, XI–3–1945, H. H. Swift (Sw); 3 males, Takoma Park, Maryland, XI–3–1945, H. and M. Townes (Tow); female, Takoma Park, Maryland, XI–19–1943, H. K. Townes (Sw); male, Great Falls, Virginia, H. and M. Townes (Tow); male, type, Bosque Co., Texas, Belfrage (US); female, Waskesiu, Saskatchewan, VI–15–1938, J. G. Rempel (Tow).

The three specimens from Lynnfield and one from Deering were reared from *Melitaea harrisii* Scud. (Harris' checker spot) in the Massachusetts gypsy moth laboratory, and have the host chrysalis on the pin. The type of *tharotis* was reared from *Phyciodes tharos* (Dru.) (the pearl crescent) by A. S. Packard. *Melitaea harrisii* is a rather uncommon nymphalid. *Physiodes tharos*, a closely related species, is very common in fields all over the United States except in the extreme south and west. Larvae of both species feed on *Aster* and related genera. A series of 8 males and 3 females of *propitius* was reared from *Anemeca ehrenbergii* (Hbn.) in Cuernavaca, Mexico, June, 1945, by N. L. H. Krauss. Six males and 2 females of this series are now in the United States National Museum.

This species is not uncommon in the fall in dry upland fields where asters are plentiful. It has been taken several times flying around small scrub pine trees (*Pinus virginiana* Mill.), a habitat in which *teres* and many other fall ichneumonids are found.

This and the following species are differentiated from other North American members of the genus by the flat, polished clypeus. *H. propitius* is separated from *teres* by the characters listed under that species. *Melanichneumon rubicundus* (Cr.) and *Pterocormus putus* (Cr.), also small, red amblytelines, might conceivably be confused with either *teres* or *propitius*. Legs of both these species are, however, short and stout; *rubicundus* has the very small gastrocoeli typical on *Melanichneumon*; *putus* females have short, blunt tipped antennae. Red species of *Aoplus*, such as *cestus* (Cr.) and *velox* (Cr.), are readily distinguished by the gastrocoeli, which are each about 0.4 the abdominal width, weakly impressed, the impressed portion not rugose; the abdominal tergites are usually mat throughout, and are weakly and finely punctate.

7. Hoplismenus teres n. sp.

Hoplismensus rutilis (!) Brimley, Insects of North Carolina, 1938, p. 405.
Hoplismenus rutilus Townes, Mem. Amer. Ent. Soc., 1944, 11: 321 (in part).

This species is very similar to *propitius* and agrees with the description given for that species except as follows:

Female.—(Figure 3). Length 8 to 13 mm. Clypeus slightly

convex, the margin broadly rounded; cheeks viewed from in front essentially straight in outline; mandibles with the outer face convex and narrowing at the apex, twisted so that the shorter tooth arises dorsad of the longer, the shorter tooth not as wide as the longer at base, the teeth unequal by a distance greater than the width of the longer at base.

Male.—(Figure 2). Length 8 to 12 mm. Clypeus and mandibles as in female; eye 1.2 to 1.6 as wide as cheek; tyloids linear, often indistinct.

The type and allotype are in the Townes Collection, Takoma Park, Maryland.

Material: 10 females and 18 males. Female *type*, male *allotype* and male *paratype*, Great Falls, Virginia, X–10–1945, H. and M. Townes (Tow). *Paratypes*, male, Charlottesville, Virginia, X–19–1941, H. K. Townes (Tow); male, Charlottesville, Virginia, X–25–1941, H. K. Townes (Tow); female, Stubblefield Falls, Virginia, X–30–1921, "on Pinus virginiana," W. L. McAtee (Sw); male, Vienna, Virginia, XII–13–1913, R. A. Cushman (US); female, Patuxent Refuge, Bowie, Maryland, IX–6–1945, R. T. Mitchell (Mitchell Collection); female, Patuxent Refuge, Bowie, Maryland, X–2–1945, R. T. Mitchell (Mitchell Collection); male, Takoma Park, Maryland, IX–29–1945, H. and M. Townes (Tow); 3 females, Takoma Park, Maryland, X–7–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, X–13–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, X–17–1945, H. and M. Townes (Tow); male and female, Takoma Park, Maryland, X–21–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, XI–3–1945, H. H. Swift (Sw); female, Takoma Park, Maryland, XI–3–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, XI–7–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, XI–7–1945, H. H. Swift (Sw); male, Takoma Park, Maryland, XI–19–1943, H. K. Townes (Sw); female, Hocking Co., Ohio, X–8–1942, R. W. Strandtmann (Tow); male, Raleigh, North Carolina, VI–2–1937, C. S. B. (US); male, Tifton, Georgia, "9–2" 1896 (US); male, Opelousas, Louisiana, IV–6–1897, G. R. Pilate (US); male, Opelousas, Louisiana, V–6–1897, G. R. Pilate (US); male, Paradise Key, Florida, VI–7, D. M. DeLong (US).

A male of *teres* was reared by the author from a chrysalis of *Precis coenia* (Hbn.) (the buckeye) at Takoma Park, Maryland, November 7, 1945. Larvae of this butterfly feed on several species of plantain, particularly *Plantago lanceolata* L. In the vicinity of Washington, D. C., *teres* is fairly common in late fall. It occurs, as does *propitius*, around small scrub pines (*Pinus virginiana* Mill.) in abandoned fields, but seems to prefer somewhat damper localities where the food plants of the host are more abundant.

The male of *teres* has previously been considered as *rutilus* by Townes and Cushman. With the discovery of several females very like the males in structure identity of this form as a distinct species becomes obvious.

TAXONOMIC AND BIONOMIC NOTES ON SOME PANAMANIAN CHIGGERS[1]
(Acarina, Trombiculinae)

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In a previous paper the author has given an account of the life history of *Eutrombicula batatas* (Linnaeus). The number and general structure of the stages of the species discussed herein are, so far as known the same of those of *E. batatas.*

Eutrombicula helleri (Oudemans)

Microtrombidium helleri Oudemans, 1911, Ent. Ber., 30: 120; Oudemans, 1912, Zool. Jahrb., Suppl. 14 (1): 15; Oudemans, 1927, Tijdschr. v. Ent., 70: 72.
Trombicula helleri, van Thiel, 1930, Parasitology, 22: 351; Ewing, 1931, Proc. U. S. Nat. Mus., 80 (8): 8.
Eutrombicula helleri Ewing, 1938, Jour. Wash. Acad. Sci., 28: 294; Radford, 1942, Parasitology, 34: 66.

This species was originally described from a larva collected on a beetle in Dutch Guiana. There is little doubt that insects are not normal hosts for this species. Oudemans later (1927) recorded specimens from the same area on man, but van Thiel casts doubt on this host record, reporting that a rodent louse was present in the same lot with the mites. Since nothing more is known of this species, its discovery in Panama is of interest. Panamanian larvae agree well with Oudemans' description and figures except that he describes a plumose seta arising from the pedipalpal tibia. This seta is present but actually arises from the tarsus or thumb. The long simple third pedipalpal seta, directed posteriorly, is particularly characteristic.

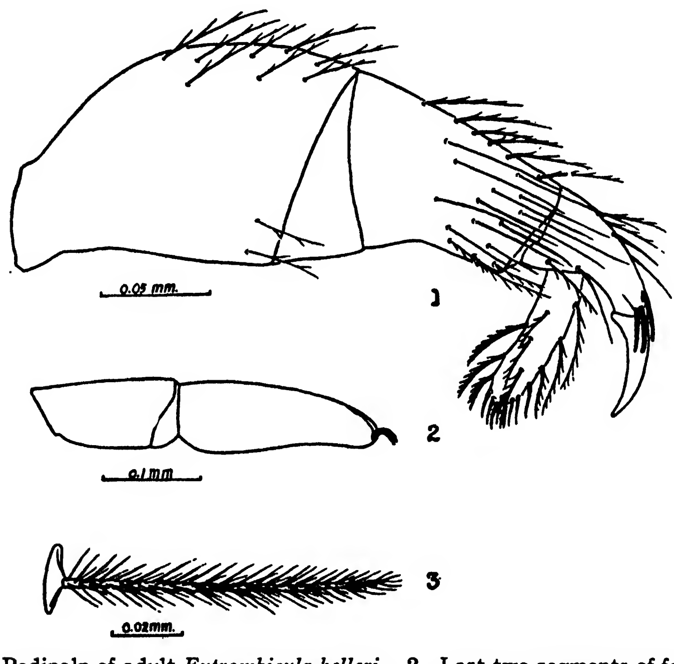
Collecting data for larvae of this species are given below:

Panama Province: Near Panama City; Point Viqué. Colon Province: Santa Rosa; Gatuncillo. Herrera Province: Parita. Canal Zone: Juan Mina; Barro Colorado Island. Dates of collection: January, February, March, July, October. Hosts: Lizard, *Ameiva praesignis* (5); Verreaux's dove, *Leptotila verreauxi* (1); a small flycatcher, *Tyrannidae* (1); domestic chicken, *Gallus gallus* (1); opossum, *Didelphis marsupialis* (1); agouti, *Dasyprocta punctata* (2); rat (unidentified native species) (1); forest rabbit, *Sylvilagus gabbi* (1); ocelot, *Felis pardalis* (1); man (1). Several specimens were also found on shoes. The numbers in parentheses indicate the number of specimens of each host on which larvae were found. This species is usually found in jungle or brush covered areas, not in open grassy places where *E. batatas* is often abundant.

Adult (female): Red. Length 1.3 mm. Body behind constriction much swollen. *Pedipalps* robust, with relatively few hairs, although

[1]The cost of publishing this article is paid by the Gorgas Memorial Laboratory.—EDITOR.

more than in *E. batatas* or *vanommerani* (fig. 1), most of the hairs on inner surface of patella simple; tibia with three (or four on one side) blunt spines arising from a small elevation on inner side of segment near base of claw; claw with a rounded swelling at base of concave margin, as in *E. batatas*; dorsal margin of claw (measured in a straight line) 0.61 times length of tibia; finger with seven or eight short simple setae at apex, other setae strongly plumose; apex of finger slightly exceeding apex of claw. *Crista* slender, measured together with pseudostigmatic area, 0.19 mm. long; crista expands posteriorly rather abruptly into broad pseudostigmatic area (0.047 mm. wide measured to lateral margins of pseudostigmata) which is truncate posteriorly. *Eyes* represented by



1. Pedipalp of adult *Eutrombicula helleri*. 2. Last two segments of foreleg of same. 3. Hair from posterior portion of body of same.

small convexities postero-lateral to pseudostigmatic area. *Genitalia* with neck of sacculi of female conspicuous. *Body hairs* slender, nearly twice as long at posterior part of body as on shoulders, plumose throughout, distal setulae slightly shorter than basal; longest body hairs 0.11mm. long. *Legs* much shorter than body, total length of foreleg about 0.9 mm. Last segment of foreleg thickest near base, 1.25 times as long as next to last segment and not thicker than that segment, 2.8 times as long as broad.

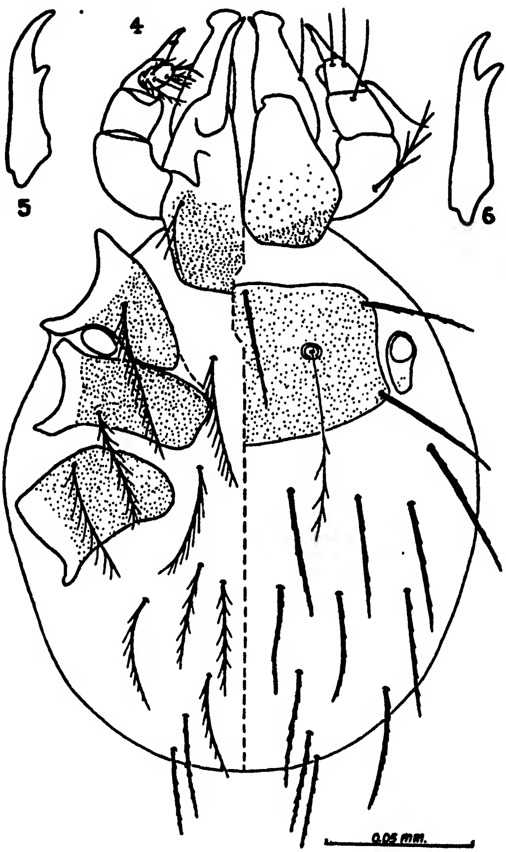
The single adult studied was found in leaf mold under trees at Santa Rosa, Colon Province, Panama, September 10, 1945 (C. D. Michener). It was placed in a jar of sterile earth and about two weeks later fifteen larvae, one of which is shown in figure 4, emerged.

This is the largest of the known adults of *Eutrombicula*.

Eutrombicula vanommereni (Schierbeek)

Trombicula vanommereni Schierbeek, 1937, Ann. Parasit. Hum. Comp., 15: 326; Schierbeek, 1938, Acta Leidensia, 12–13: 266; Radford, 1942, Parasitology, 34: 60.

This species was originally described from larvae from lizards collected in Dutch Guiana. A form which appears to be the same is common on lizards in Panama. Our specimens agree with the original



4. Larva of *Eutrombicula helleri* reared from adult illustrated in figures 1 to 3. 5. Pedipalpal claw of same. 6. Pedipalpal claw of larval *Eutrombicula vanommereni.*

description and differ from the accompanying figures chiefly in the less conspicuous posterior eyes. Except for the plumose third pedipalpal seta and the shape of the pedipalpal claw (fig. 6), *E. vanommereni* larvae agree with the figure of *E. helleri* (fig. 4).

This species is related to *E. alfreddugèsi* (Oudemans) from which the larva differs by having the second pedipalpal seta simple. It is also

close to *E. tropica* (Ewing). According to Dr. G. W. Wharton, who kindly examined the type of *E. tropica* for me, the second pedipalpal seta of that species is simple as in *E. vanommereni*, but the third is also simple, unlike the latter species. In this respect *E. tropica* is similar to *E. göldii* (Oudemans). Although these species are distinguished by only minute differences, the characters are constant in a large series of specimens from Panama. Apparently there are also differences between the adults of *E. alfreddugèsi, vanommereni* and *göldii*.

Collection data for larvae of *E. vanommereni* are given below:

Panama Province: Matías Hernández; Las Guacas. Colon Province: Santa Rosa; Agua Clara; three-fourths mile south of Río Limón; Gatuncillo. Darien Province: El Real. Canal Zone: Juan Mina. Dates of collection: December, January, February, March, June. Hosts: lizard, *Ameiva praesignis* (14); snake, *Drymarchon corais* (1); domestic chicken, *Gallus gallus* (1); Lafresnaye's sparrow, *Arremonops conirostris* (1); peccary, *Pecary angulatus* (1); white tailed deer, *Odocoileus chiriquensis* (1); domestic goat (1); spotted agouti, *Dasyprocta punctata* (1); capybara, *Hydrochoerus isthmius* (1); rat (unidentified native species) (2); forest rabbit, *Sylvilagus gabbi* (1). Specimens were taken on boots on many occasions.

The numbers in parentheses indicate the number of specimens of each host on which larvae were found. This species is often found in open grassy places in company with *E. batatas*. It also occurs in bushy areas.

On lizards (*Ameiva praesignis*) larvae sometimes remain attached for over three weeks before dropping, and do not detach on the death of the host. On the other hand, larvae on a snake (*Drymarchon corais*) detached soon after the death of the host.

Protonymph: Apparently not distinguishable from that of *E. batatas*.

Nymph: Pale red. Length about 0.5 mm. Similar to adult except for usual nymphal characters. Finger of pedipalp not parallel sided but slightly thickened basad of middle, bearing four or five short simple setae at apex. Longest hairs of shoulders about half as long as those of posterior end of body. Last segment of foreleg 1.39 to 1.53 times as long as next to last segment, 1.7 to 2.2 times as long as broad.

Preadult: Unknown.

Adult: Red. Length 0.9 to 1.1 mm. Body shape about as in *E. batatas*, that portion of body behind constriction not unusually swollen. *Pedipalp* with few hairs, as in *E. batatas*, most of those of inner margin of patella simple; inner surface of tibia with the usual three blunt spines arising from subapical protuberances and a single sharply pointed spine arising at about middle of upper margin; claw with rather sharp swelling at base of concave margin, as in *E. batatas*, dorsal margin of claw (measured in straight line, not around curve of claw) 0.61 to 0.62 times length of tibia; finger with seven or eight short simple setae at apex, other setae strongly plumose; finger shaped as in *E. helleri*, slightly exceeding claw. *Crista* slender, measured together with pseudostigmatic area 0.15 to 0.17 mm. long; crista expands posteriorly rather abruptly into broad pseudostigmatic area (0.059 to 0.075 mm. wide measured to lateral margins of pseudostigmata) which is truncate

posteriorly in some views, bilobated, the lobes separated by width of a lobe, in others; pseudostigmatic area with a transverse arcuate ridge anterior to pseudostigmata, as figured for *E. batatas*. Pseudostigmatic organs about as long as crista, with a few branches as in *E. batatas*. *Eyes* less conspicuous than in *E. batatas*, larger than in *E. helleri*, about half as wide as width of pseudostigmatic area. *Genitalia* with necks of sacculi of female conspicuous. *Body hairs* shaped about as figured for *E. batatas*, with long setulae throughout their lengths, longest hairs of shoulders about two-thirds as long as those of posterior end of body; longest body hairs 0.045 to 0.047 mm. long. *Legs* shorter than body, total length of foreleg about 0.73 mm.; forelegs longer and thicker than other legs, last segment thickest near base, not so slender apically as figured for *E. helleri*, 1.36 to 1.41 times as long as next to last segment and not thicker than that segment, 2.1 to 2.6 times as long as broad.

Nymphs and adults have not been collected in the field but have been reared from larvae on lizards (*Ameiva praesignis*), using the methods described elsewhere for *E. batatas*. The duration of the free living stages is apparently not greatly different from that of *E. batatas*, as shown by the following: larvae dropped from host November 22, nymphs observed December 2 and adults December 24.

Eutrombicula batatas (Linnaeus)

This species was the subject of a previous paper (Michener, 1946, Ann. Ent. Soc. Amer., 39: 101–118). The following synonymy completes that given there:

Trombidium batatas Oudemans, 1937, Kritisch Hist. Overzicht der Acarologie, Band D, p. 1384.

Eutrombicula batatas Michener, 1946, Ann. Rep. Gorgas Mem. Lab., 1945: 23; Michener, 1946, Ann. Ent. Soc. Amer., 39: 101; Michener, 1946, Amer. Jour. Trop. Med., 26: 251.

Acariscus flui and *hominis* Ewing, 1946, Proc. Biol. Soc. Wash., 59: 22.

With regard to the discussion of the plumosity of the third palpal seta of the larva, it should be noted that Schierbeek (1937, Ann. Parasit. Hum. Comp., 15: 326) states on the authority of van Thiel that this seta is plumose and was overlooked in the original description of *Trombicula flui* van Thiel. Islas (1943, An. Inst. Biol. Univ. Nac. Mexico, 14: 441) shows this seta as plumose in his figure of a Mexican specimen.

This mite has been collected at or near Santa Rosa, Colon Province, Panama, on several additional hosts[2] since the writing of the previous paper dealing with this species. These hosts are listed as follows: Cayenne wood rail, *Aramides cajanea* (1); little blue heron, *Florida caerulea* (5); Panama house wren, *Troglodytes musculus* (1); short-legged wood pewee, *Myiochanes cinereus* (1); Berlepsch's kingbird, *Tryannus melancholicus* (1); forest rabbit, *Sylvilagus gabbi* (1); domestic cattle (2). The numbers in parentheses indicate the number of specimens of each host on which larvae were found. Most of these hosts appear to be of

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[2]Dr. Jorge Boshell Manrique writes that the "gallineta," mentioned as a host (of *pastorae*) by Boshell and Kerr, is the guinea hen (*Numida meleagris*), also recorded as a host by Ewing.

minor importance, only a few mites having been found on each. However, the little blue heron is important, some of the individuals examined having had nearly one thousand chiggers on them. This may be of importance in connection with an understanding of the survival of the species during the dry season. On the Pacific side of Panama *E. batatas* disappears during the dry season from most grassy areas around houses, where its main host is the domestic chicken. It was thought that

TABLE I

CHARACTERS OF ADULTS OF PANAMANIAN EUTROMBICULAS

(All measurements are in microns except as otherwise indicated.)

	batatas	*vanommereni*	*helleri*
Length (mm.)	0.7–1.0	0.9–1.1	1.3
Body shape	normal		swollen posteriorly
Length of pedipalpal claw	32–38	38–42	46
Dorsal margin of pedipalpal claw / Length of pedipalpal tibia	0.60–0.66	0.61–0.62	0.61
Number of short simple setae at apex of palpal finger	3–4	7–8	7–8
Length of crista and pseudostigmatic area	120–150	150–170	190
Breadth of pseudostigmatic area	47–57	59–75	47
Diameter of eye / Width of pseudostigmatic area	0.75–1.0	0.5	0.4
Length of longest shoulder hairs / Length of hairs at posterior end of body	0.7–0.8	0.6–0.7	0.5
Length of last segment of foreleg / Length of next to last segment of foreleg	1.41–1.49	1.36–1.41	1.25
Length of longest hairs of posterior end of body	36–40	45–47	110

perhaps the species survived in deep cracks in the soil, but this was not substantiated by digging. It now seems probable that it passes the dry season in damp grassy areas along streams frequented by herons and other birds, and is reestablished each wet season in the higher areas away from streams by movements of infested birds.

The number of eggs laid by individuals of this species is unknown. However, twenty-six larvae appeared in eighteen days in a jar of sterilized soil in which a single female of *E. batatas* was kept.

In connection with rearing methods, it should be noted that a far better method of feeding nymphs and adults than that used by me has been devised by Lt. Dale Jenkins. Following G. W. Wharton, he used insect eggs as food, and it seems probable that this is the normal food for nymphal and adult chiggers. However, a small number of individuals were reared by me in the absence of insect eggs when chicken manure was present in the rearing jars.

The characters useful for distinguishing the adults of the three Panamanian species of *Eutrombicula* known in that stage are indicated in Table I. Certain other characters which have been useful for other trombiculines are included in this table, even though of little value for the separation of the Panamanian species.

Trombicula panamensis Ewing

Trombicula panamensis Ewing, 1925, Amer. Jour. Trop. Med., 5: 259; Ewing, 1931, Proc. U. S. Nat. Mus., 8(8): 9.
Eutrombicula panamensis Ewing, 1938, Jour. Wash. Acad. Sci., 28: 294; Radford, 1942, Parasit., 34: 66.
Acariscus panamensis Ewing, 1943, Proc. Ent. Soc. Wash., 45: 59.

Larvae were found on two rats (unidentified native species) from Gatuncillo, Colon Province, Panama, collected by H. Trapido on March 5, 1945.

Most of the specimens have two subequal accessory prongs on the pedipalpal claws so that the species falls in *Trombicula*, not *Eutrombicula*. Ewing indicated that proper generic assignment was doubtful when he included the species in *Acariscus*.

Apparently there is complete intergradation, through various stages in the reduction of one of the accessory prongs of the claw, between typical *Trombicula* with three prongs in the palpal claws and the group of *Eutrombicula* in which there is a single outer prong shorter than the principal one. It is therefore believed that this group of *Eutrombicula* (including such species as *bruyanti* (Oudemans) and *panamensis* Ewing) should be transferred to *Trombicula*. The typical Eutrombiculas lack outer prongs on the pedipalpal claws but have a subapical or median tooth on the inner side.

ACKNOWLEDGMENTS

The author is indebted to the Gorgas Memorial Laboratory, Panama City, R. P., and particularly to its Director, Dr. Herbert C. Clark, for excellent facilities provided for this work. Roy Melvin and H. L. Dunn collected some of the larvae used in this study.

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THREE NEW MUSCOID FLIES FROM GUAM[1]

GEORGE E. BOHART[2] AND J. LINSLEY GRESSITT[3]

The following three species were collected in the course of biological studies of filth-inhabiting flies conducted at U. S. Naval Medical Research Unit No. 2, on Guam.

The holotypes and allotypes are deposited in the U. S. National Museum and the paratypes are in the California Academy of Sciences, the collection of the Hawaiian Sugar Planters Association Experiment Station, and the U. S. National Museum.

Subfamily **Phaoniinae**

Genus **Dichaetomyia** Malloch

Dichaetomyia Mall., 1921, Ann. Mag. Nat. Hist. (9) 7: 163 (type: *D. polita* Mall.).

This genus is a large one, distributed over most of the Ethiopian, Oriental and southern Australasian regions. The following two new species are apparently the first ones to be recorded from an oceanic Pacific island north of Fiji and Samoa. Many species of this genus which were originally described in the genus *Mydaea* have not yet been associated with *Dichaetomyia*.

Dichaetomyia saperoi, n. sp.

Figure 1

Holotype, male.—Length 5.7 mm.; breadth at humeri 2 mm.; length of wing 5.5 mm.; testaceous, reddish orange on upper side of thorax, pitchy black on central two-thirds of abdomen, tarsi and mid- and hind tibiae pitchy brown.

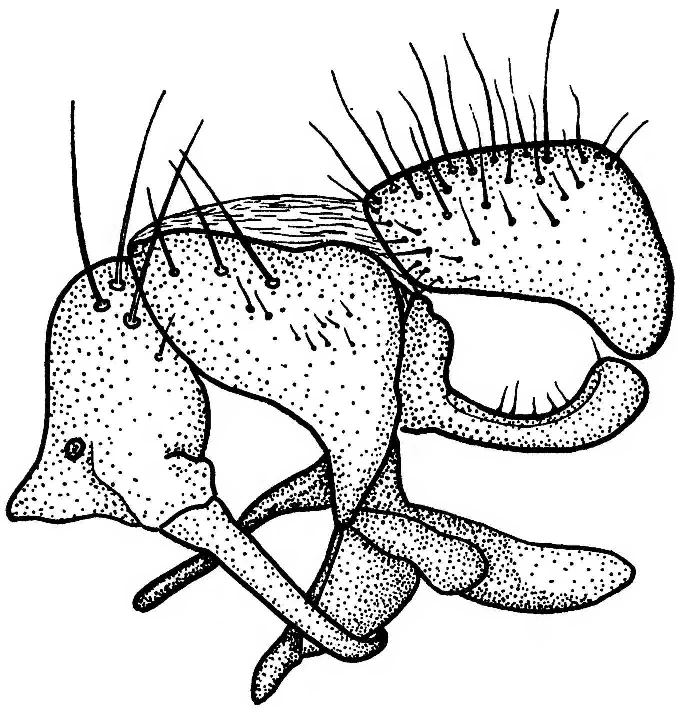
Head about one-tenth wider than deep; narrowest width of frons less than diameter of ocellus; frons, parafacials, genae, and occiput black with silver pruinosity, antennal groove reddish, apex of clypeus pale testaceous; hairs and bristles of head (except on arista and labellum) black; frontals 5, the uppermost common to both sides; antenna testaceous, second segment orange, third slightly darkened apically, second segment with distal bristle one-third longer than proximal, arista darkening to black distally, 14 pinnae above and 12 below; palpus pitchy brown, about as long as third antennal segment, hardly twice as wide at widest point as at narrowest; haustellum with basal two-thirds pale testaceous. *Thorax* rich golden testaceous, prescutum and scutum orange with feeble whitish pruinosity when viewed from behind; 2 presutural and 4 postsutural dorsocentrals; posterior dorsocentrals and acrosticals forming a nearly straight line of equidistant bristles; humerals

[1]The opinions expressed in this paper are those of the authors and do not necessarily represent those of the Navy Department.

[2]Lieutenant-Commander, H(S), USNR, Research Division, Bureau of Medicine and Surgery, Navy Department.

[3]Formerly Lieutenant (j.g.), H(S), USNR, Naval Medical Research Unit No. 2.

2, subequal; prostigmatics 2, lower weak; meso-, ptero- and sternopleura with numerous black hairs about one-half as long as anterior sternopleural bristle; anterior and posterior intra-alars much weaker than middle one, the latter displaced laterad about 4 bristle-socket diameters; middle supra-alar more than twice as long as anterior one; metathoracic spiracle with about 10 black setae along lower margin; squamopleuron with 2 or 3 black hairs at extreme upper corner and lateral postscutellum with about 12 scattered small ones. *Wing* with membrane slightly yellowish especially on basal fourth and anterior to second vein; veins



DICHAETOMYIA SAPEROI

FIG. 1. *Dichaetomyia saperoi* G. Bohart and Gressitt, news pecies, genitalia of male paratopotype, left side.

fuscous; marginal crossvein slightly curved outwardly at anterior third and more strongly curved inwardly at posterior third; third and fourth longitudinal veins about equally curved upwards near apices; squamae slightly grayish, superior one with blackish rim and fringe hairs. *Haltere* testaceous. *Legs* with coxae and femora testaceous; fore tibia yellowish; mid- and hind tibiae and all tarsi pitchy black; fore femur with 9 long posteroventrals, 11 dorsals, the basal 3 weak, 11 posterodorsals, the distal 2 weak; midfemur with 6 widely spaced weak bristles on posteroventral margin, a transverse row of 3 preapical

bristles posterodorsally, and one short preapical anterodorsal bristle; hind femur with 15 bristles along anterodorsal margin; 3 preapical ones posterodorsally, 3 strong ones along apical third of anteroventral margin, and 4 strong ones along middle portion of anteroventral margin; fore tibia without bristles except at apex; midtibia divided into thirds by 2 stout bristles on posterior margin, encircled at apex by 5 apical and preapical bristles; hind tibia with one median anterodorsal and one median anteroventral bristle. *Abdomen* with first 2 segments, central, dorsal and ventral portions of third tergite, central portion of fifth tergite, genital segments and all sternites testaceous; central portion of fourth tergite dark reddish brown; remainder of abdomen pitchy black; laterally and dorsally fourth and fifth tergites with bristles in transverse rows as follows: apex of fourth 9 (subequally spaced), middle of fifth 6, apex of fifth 6; second sternite with a median pair of subapical, and a lateral pair of apical, bristles; third and fourth sternites each with 2 pairs of lateral bristles on apical third.

Allotype, female.—Length 5.8 mm.; breadth at humeri 2 mm.; length of wing 5.5 mm. Breadth of frons at level of posterior ocelli three-fourteenths of head breadth, at level of frontal lunule, one-third of head breadth; frontal stripe sooty black except for a slightly shiny ill-defined extension of ocellar triangle; frontals 5, upper 2 closely spaced; squamae yellowish with pale rims and fringes; midtibia with 3 bristles along posterior margin, 2 near middle, one midway between middle and apex; fourth abdominal tergite entirely black.

Paratypes.—Length 5.3–6 mm. Third abdominal tergite varying from dark reddish brown to black medially; frontal bristles varying from 5 to 6, the next to lowest sometimes minute; dorsal bristles on midtibia varying from 2 to 3 in both sexes; laterally and dorsally fourth and fifth tergites with bristles in transverse rows varying as follows: apex of fourth 9–11, middle of fifth 6, with a lateral ventral bristle sometimes appearing near lateral line, apex of fifth 6, the lateral pair sometimes appearing to be lateroventral.

Genitalia of male paratype illustrated in figure 1.

Holotype, male (No. 57916, U. S. National Museum), Pt. Ritidian, Guam, alt. 550 ft., on vegetation in dense forest, June 28, 1945, G. E. Bohart and J. L. Gressitt; *allotopotype*, female (U. S. N. M.), June 19, 1945, G. R. Norris; five *paratopotypes*, two males, three females, June 2 to August 2, G. Bohart and Gressitt; one *paratype*, male, Pt. Oca, Guam, June, 1945, taken in light trap, G. Bohart and Gressitt; six *paratypes*, all females, Pt. Ritidian, Guam, on human feces, J. L. Gressitt; three *paratypes*, females, were taken at Dededo, Guam, September 22, 1944, by D. G. Hall.

This species belongs to the *rufa* group, and differs from *D. rufa* (Stein) in having the mesopleuron with strong black hairs dorsally, from *D. megopthalma* Mall. in having the abdomen largely dark instead of completely pale, from *D. decipiens* (Stein), new combination, in having the pubescence of the occiput and underpart of face entirely black, and the tip of the abdomen yellowish instead of pitchy, from *D. flavohirta* Mall. in the completely black fourth abdominal segment and black meso- and sternopleural hairs, from *D. terraereginae* Mall. in having a row of long bristles on the posterovental margin near the middle of the

hind femur, instead of a short row of very strong bristles on the apical fourth preceded by minute hairs, and from *D. impar* (Stein), new combination, in having the palpi, tibiae and tarsi dark.

This species is named in honor of Captain J. J. Sapero, MC, USNR, in recognition of his role in fostering entomological work in the Navy.

Dichaetomyia nigroscuta, n. sp.

Holotype, female.—Length 6.6 mm.; breadth at humeri 2.2 mm.; length of wing 6.2 mm.; reddish orange, the head and thorax, except antennae, humeral area, and scutellum, largely black.

Head with breadth to depth 6 : 7.5; breadth of frons at level of posterior ocelli four-fifths of head breadth, at level of frontal lunule, one-third of head breadth; frontal stripe slightly expanded at middle, where it is nearly two-thirds as broad as its median length; frons, parafacials, genae, occiput and antennal grooves black with silvery pruinosity, except for frontal stripe which is velvety black; clypeus nearly white; hairs and bristles of head (except on arista and labellum) black; frontals 6, second and fourth from bottom weak, lower 2 more widely spaced; antenna testaceous, second segment with subapical bristle three times as long as others; arista testaceous in basal third, otherwise black, dorsally with 13 pinnae and ventrally with 7; palpus velvety black, about as long as third antennal segment, over twice as wide at widest point as at narrowest; haustellum pitchy black. *Thorax* black with feeble pale pruinosity; humeri, sides of anterior declivity of prescutum, scutellum and posterolateral corners of scutum testaceous; sides of prescutum and scutum pitchy brown; sides and venter of thorax pitchy black, becoming brownish posteriorly; dorsum with a pair of extremely feeble vittae on prescutum between dorsocentrals; 2 presutural and 3 postsutural dorsocentrals; posterior dorsocentrals and acrosticals forming a nearly straight line of equidistant bristles; humerals 2, inner one two-thirds as long as outer; prostigmatics 3, middle one one-third longer than others; meso-, sterno- and pteropleura with a few black hairs less than one-fourth as long as sternopleural bristles; intra-alars 3, middle one displaced laterad 3 bristle-socket diameters, one-fourth longer than others; supra-alars 3, nearly in a straight line, middle one over twice as long as others; metathoracic spiracle with about 5 long black setae. *Wing* yellowish, especially anterior to second vein; veins testaceous basally, dark brown apically; marginal crossvein slightly curved outwardly at anterior third and more strongly curved inwardly at posterior third; squamae yellow. *Haltere* creamy yellow. *Legs* black; fore femur with 11 long posteroventrals, 7 anterodorsals and 9 dorsals; midfemur with a row of 3 bristles on basal half of ventral margin, middle one strongest, and 5 preapical bristles; hind femur with 14 anterodorsals, and 2 very strong bristles on apical third of anteroventral margin; ventral margin with a single strong bristle at basal fourth; fore tibia without bristles except at apex; midtibia roughly divided into thirds by 2 stout bristles on posterior margin; hind tibia with a median anterodorsal bristle and 2 anteroventrals, the proximal one opposite anterodorsal bristle. *Abdomen* reddish orange, sixth and seventh segments pale testaceous; laterally and dorsally fourth and

fifth tergites with bristles in transverse rows as follows: apex of fourth 12, middle of fifth 6, apex of fifth 6; second sternite with a transverse row of 4 subapical bristles; third and fourth sternites each with a pair of strong subapicals.

Paratype, female.—Length 7.2 mm.; frontal stripe three-fourths as broad as length at middle; abdominal bristles fewer in number than in holotype.

Holotype, female (No. 57917, U. S. National Museum), Mt. Santa Rosa, Guam, alt. 400 feet, *Pandanus* thicket, June 3, 1945, G. E. Bohart and J. L. Gressitt; *paratype*, female (Calif. Acad. Sci.), Mungmung, Guam, alt. 150 feet, taken in woods in trap baited with dead toads, July 10, 1945, G. Bohart and Gressitt.

This species is apparently not closely related to any previously described. It differs from *D. quadrata* (Wied.) in lacking the gray vittae of the mesonotum, in having the legs entirely black, the postsutural dorsocentrals three instead of four, and in many other characters.

Subfamily **Stomoxidinae**

Genus **Siphona** Meigen

Siphona Meig., 1803 (not 1824), Illiger's Mag. Ins. 2: 281 (type: *Stomoxys irritans* of Fabr. = *Stomoxys stimulans* Meig.).

This genus, as here considered, includes a group typified by *stimulans* which has a relatively short proboscis, long dilated palpus, and pinnae above and below on the arista. It corresponds to the genus *Haematobia* as used by Seguy.[1] Seguy's genus *Lyperosia* becomes *Haematobia* since the type of both is *Conops irritans* Linnaeus, and *Haematobia* is the older name.

Siphona carabao, n. sp.

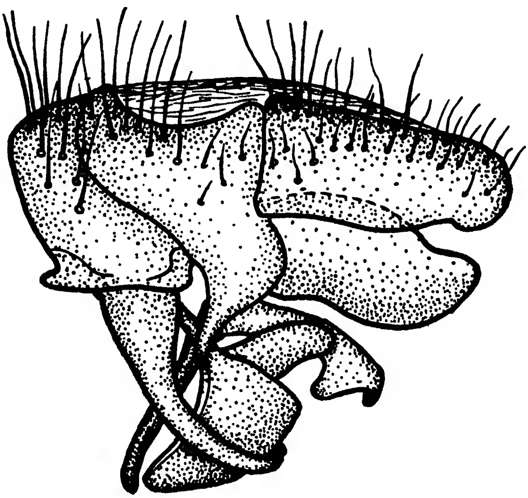
Figure 2

Holotype, male.—Length 4.2 mm. (apex of abdomen recurved ventrally); breadth at humeri 1.8 mm.; greatest abdominal breadth 2.2 mm.; length of wing 4.3 mm. Body black to brown with dense gray-green to buff pruinosity; mesonotum with 2 pairs of dark brown sublateral stripes and a feeble interrupted median one.

Head almost one-fourth wider than deep; narrowest width of frons between eyes one-twelfth of greatest head-width; width of frons at vertex slightly over one-sixth of greatest head-width; in profile, parafacials practically flush with anterior margins of eyes, vibrissal angle projecting about as far forward as eye, with its longest bristle nearly three times as long as other vibrissae; frontal bristles in a single row of 14 on each side, mostly somewhat longer than narrowest width of frons; face, except for antennal grooves and frontal stripe, densely clothed with velvety golden pubescence; frontal stripe uniformly dark brown, narrower at middle than diameter of an ocellus; antenna dark brown, first segment with a row of inconspicuous bristles less than one-third as long as longest bristle of second segment; third segment oblong, twice

[1]Seguy, 1937, Gen. Ins. 205: 434.

as long as broad; arista with 10 dorsal pinnae of subequal length, the distalmost extending slightly beyond aristal apex, and 5 ventral bristles, the basalmost one-half as long as distelmost, and the latter inserted slightly basad to antepenultimate above; palpus testaceous except at tip, nearly three-fifths as long as head width, apical half expanded to fully twice narrowest part, apex with bristles much longer and stronger than elsewhere; haustellum dark reddish brown, pitchy apically, one-sixth longer than palpus. *Thorax* with pale gray pruinosity, having a distinct greenish cast especially close to lateral stripes of notum; viewed from above with light from behind, inner lateral stripe complete from anterior thoracic margin to middle of scutum, and outer stripe con-



SIPHONA CARABAO

FIG. 2. *Siphona carabao* G. Bohart and Gressitt, new species, genitalia of male paratopotype, left side.

sisting of an oblique mark ending before scutum and continued as a free longitudinal stripe more closely approaching anterior, than posterior, border; median line of scutum with a triangular spot at anterior margin and a diffuse mark starting near center and broadening to posterior margin; vestiture black, suberect, mostly shorter than humeral cross-vein, about 10 hairs in a transverse row between inner notal stripes; supra-alars 1, post-alars 2; principal mesopleurals 13, fourth from top strongest, but only slightly longer than most of others; presutural much weaker than notopleurals; hairs on anterior portion of sternopleuron less than one-fifth as long as anterior sternopleural. *Wing* nearly colorless, slightly infuscated on basal quarter; first and third veins completely without distinctive hairs or bristles; squamae translucent dirty white; haltere creamy. *Legs* with femora gray, yellowish apically,

tibiae dull testaceous, tarsi nearly black; anterior surface of midfemur near the middle with a short oblique row of bristles somewhat longer than remainder; mid- and hind tibiae without strong bristles except at apices. ***Abdomen*** more buff in color than thorax and lacking green pruinosity; median line of first 3 tergites indistinctly brown; when viewed from behind, first 3 tergites each with a pair of broad oval brown areas occupying about one-half of their respective tergites; fourth tergite, viewed at a low angle from in front, with basal half brownish.

Allotype, female.—Length 4.0 mm. (abdomen recurved); breadth at humeri 1.6 mm. Frons near narrowest point two-fifths as broad as head, slightly broader at antennal insertions; frontal stripe slightly expanded at middle, with median length scarcely greater than width; face pale golden, silvery beneath, rich golden near vertex; dark markings of thorax less distinct than in holotype; femora yellowish.

Paratypes.—Length 4–5.5 mm.; 2 to 6 bristles on underside of arista; anterior sternopleurals sometimes weak; squamae sometimes yellowish apically and with distinctly yellowish rims.

Holotype, male (No. 57918, U. S. National Museum), Asan, south of Agãna, Guam, Mariana Islands, July 9, 1945, reared from fresh cattle dung, G. E. Bohart and J. L. Gressitt; ***allotopotype***, female (U. S. N. M.), July 9; eleven ***paratopotypes***, July, 1945; seven ***paratypes***, southeastern coast of Guam, May 6, 1945, Pt. Manell, southern end of Guam, July 6, 1945, Ulomnia, southeastern Guam, May 10, 1945; all sucking blood from flanks of water buffalo or cattle, or reared from their feces. One male specimen taken at Saipan Island from a cow, July 1944, is apparently referable to the same species. Another male specimen from Ulomnia, Guam, appears to represent a color variant of this species. Its wings and squamae are distinctly yellow, the pruinosity of its body has a pronounced golden sheen, and its face is uniformly rich golden.

This species differs from ***Siphona sanguisugens*** (Austen), new combination, in lacking bristles on the third wing vein, and from ***rufipes*** Brunetti (which Suguy listed as the female of ***sanguisugens***) in having one instead of two supra-alars and two instead of one post-alars. There are twice as many hairs in a row between inner stripes of scutum as in ***Siphona perturbans*** (Bezzi), new combination, and one-half as many as in ***Siphona sanguinolenta*** (Austen), new combination. The prescutal hairs in ***carabao*** are much shorter than those of ***Siphona stimulans*** (Meigen) and ***sanguinolenta***, and somewhat longer than those of ***perturbans***.

NEARCTIC STENUS OF THE CROCEATUS GROUP
(Coleoptera, Staphylinidae)

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The *croceatus* group of *Stenus* in the Nearctic region contains the species which belong to the subgenus ***Hemistenus*** Mots. They are characterized by having the abdomen strongly margined (paratergites present and horizontal) on tergites III to VI; tarsus short and broadened toward the apex, about 3–5 length of tibia and with third and fourth segments conspicuously bilobed (fig. 1); pronotum evenly rounded and without a longitudinal depression at middle. In addition to these features, the Nearctic species are generally 4 to 6 mm. in length. Body deep black, nearly evenly and finely punctured, and clothed with decumbent silvery pubescence. First antennal segment shining black, remainder reddish yellow and often dusky toward apex. Tarsi usually slightly to conspicuously lighter than femora and tibiae.

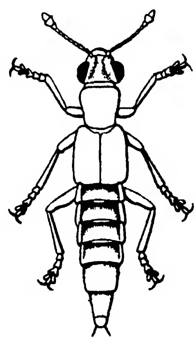


FIG. 1. *Stenus croceatus* Csy.

Although representatives of this group have been infrequent in collections submitted for study, their general distribution appears to be transcontinental chiefly through the northern United States and Canada. So far as known, the species are found in sphagnum bogs, wet mountain meadows and marsh habitats where they are at home walking or skimming about on the water surface.

The only paper treating the Nearctic species of this group is by Casey (1884) in which he keyed and described four species. Later (1892) he synonymized one of these, but evidence is presented here to show that it is valid.

The study of a greater series than has been previously assembled has shown that the most reliable characters for distinguishing the species are the male and female genitalia or associated abdominal segments.

These structures were treated with cold 5 to 10 per cent potassium hydroxide, and after washing were preserved in a small glycerine vial attached to the pin with the adult.

The terminology for the identity of the abdominal sclerites is essentially that of Blackwelder (1936). However, there is some evidence for considering that the apical flap of the ninth tergite of Blackwelder may be the tenth, and that the lateral plates of the ninth tergite join on the dorsum in *Stenus* to complete the dorsal part of the ninth segment. The ventral side of this segment is membranous; the following sternite is well developed and may be the tenth. In this case, the tenth sternite in *Stenus* would appear to follow the eighth. In addition to using these parts in this paper, an additional structure in the female genitalia is used to distinguish two species. This structure, which lies in the membrane on the inside of the genital capsule, is elongate, dorsoventrally flattened, and enlarged toward the apex of the abdomen. Possibly it may be the spermatheca although it is not circular in cross section similar to that observed in some females of other genera of Staphylinidae. It was not observed in females of *S. croceatus* and *S. fraternus*.

I am indebted to Dr. E. A. Chapin of the United States National Museum for comparing material with certain of the Casey types. I am also grateful to many institutions and individuals who have contributed material for these studies.

KEY TO SPECIES

1. Eighth sternite[1] emarginate at middle of posterior margin (males)...........2
   Eighth sternite evenly rounded or angularly produced on posterior margin (females)..6
2. Apex of femur and base of tibia black, remainder of leg yellow; apex of median lobe of genitalia not reaching apices of lateral lobes, (fig. 18A), **croceatus**
   Tibia and femur uniformly black; apex of median lobe reaching or extending beyond apices of lateral lobes...3
3. Last sternite emarginate at apex, the lateral angles distinct (fig. 14); apex of median lobe reaching apices of lateral lobes; lateral lobes very broad and conspicuously rounded from base to apex (fig. 19A).........**fraternus**
   Last sternite truncate or slightly rounded at apex as in figs. 10, 11; apex of median lobe extended beyond apices of lateral lobes; lateral lobes slender and nearly straight, as in figs. 21A, 22.........................4
4. Basal piece of last sternite evenly narrowed toward apex of sternite (fig. 11); median lobe of genitalia evenly narrowed to blunt apex (fig. 21A) and with a recurved apical ventral hook (fig. 21B).................**umbratilis**
   Basal piece of last sternite subparallel along sides then narrowed toward apex of sternite (fig. 10); median lobe of genitalia slightly broadened and very thin at apex (figs. 20A and 20B)............................5
5. Margin of aedeagal opening distinctly angulate as in fig. 20A........**retrusus**
   Margin of aedeagal opening nearly straight as in fig. 22................**vista**
6. Apex of eighth sternite evenly rounded (fig. 9); apex of valvifer nearly evenly rounded and distinctly crenulate along apical margin (fig. 7), **croceatus**
   Apex of eighth sternite rather suddenly narrowed, the narrowed sides emarginate and produced into an angulate lobe (fig. 8); apex of valvifer slightly rounded or subtruncate but without conspicuous crenulations.....7

[1]In counting segments, note that the first large cylindrical segment is morphologically the third.

7. Apex of valvifer acutely angled externally (fig. 5) .... **fraternus**
   Apex of valvifer nearly truncate, or rounded externally as in figs. 4 and 6..... 8
8. Anterior margin of ninth tergite very deeply and angularly emarginate as in fig. 3 .... **umbratilis**
   Anterior margin of ninth tergite with emargination evenly rounded and shallower as in fig. 2 9
9. Spermatheca distinctly triangular with the base about one-half to two-thirds its total length (fig. 17) .... **retrusus**
   Spermatheca nearly truncate at base with base slightly less than one-third its total length (fig. 16) .... **vista**

Stenus croceatus Casey

Stenus croceatus Casey, 1884: 159.

The bicolored femur and tibia in both sexes will at once distinguish this species from all others in the group. In addition to some features of the male pointed out in the key, the structures of the aedeagus are more complicated than in the other species (fig. 18B). The last sternite of the male is emarginate and distinctly crenulate on the posterior margin and with postero-lateral angles distinct (fig. 12).

Known from District of Columbia, Illinois, Manitoba, Massachusetts, Michigan, New York, New Jersey, Nebraska, Ontario, and Quebec. In Illinois it has been taken abundantly in many marshes, especially in the northeast section of the state. They seem to prefer cattail marshes but have been found in grassy marshes and sphagnum bogs. This species often occurs among the cattails a hundred or more feet from land, and has the remarkable ability to skim gracefully on the surface of the water. This method of locomotion has been described for some British representatives of the genus (Joy, 1910) and is achieved by the secretion from repugnatorial glands at the end of the abdomen. The secretion from these glands lowers the surface tension of the water round the caudal end of the beetle, and the greater surface tension on which the front parts of the beetle rests pulls it rapidly forward.

Stenus fraternus Casey

Stenus fraternus Casey, 1884: 155.
Stenus fraternus Casey, 1892: 712.

Superficially resembles *umbratilis* Casey very closely. Casey (1892) synonymized *fraternus* with *umbratilis* without comment. Males of the two species show striking differences in the last sternite as well as in the genitalia. In this species the postero-lateral angles of this sternite in both sexes is acute. In *umbratilis*, the angles are blunt and the entire end of the sternite is subtruncate.

Casey originally recorded the species from three specimens taken in Wyoming Territory, and Marquette, Michigan. Additional material has been examined from: ALBERTA—Edmonton, June to August, 1917 and 1918, F. S. Carr. COLORADO—Ten miles north of Rabbit Ear Pass, August 21, 1941, H. C. Severin. MANITOBA—Stonewall, May 25, 1919, J. B. Wallis. NORTHWEST TERRITORY—Tununuk, Mackenzie River, August 10, 1930, O. Bryant.

Stenus umbratilis Casey

Stenus umbratilis Casey, 1884: 156.
Stenus umbratilis Casey, 1892: 712.

The important characters distinguishing this species and *fraternus* are given in the key, and in notes under *fraternus*. These two species form a complex within the *croceatus* group, having a distinct carina bordering the punctured area on the last sternite of the males. In other species of the *croceatus* group, the carina is completely absent. The *umbratilis* complex also differs by having the tarsi only slightly lighter than the tibiae, and the apex of the median lobe of the male genitalia is recurved.

Described from Lake Quesnel, British Columbia. Additional records are noted from: ALBERTA—Edmonton, June 25, 1917, F. S. Carr. MANITOBA—Churchill, July and August, 1937, W. J. Brown; H. B. R., mile 214, July 9, 1917, J. B. Wallis; Piquitenary, July 24 to July 26, 1917, J. B. Wallis. NORTHWEST TERRITORY—Aklavik, April 27, 1931, and August 13, 1932, O. Bryant. QUEBEC—Natashquan, August 10, 1929, W. J. Brown.

Stenus retrusus Casey

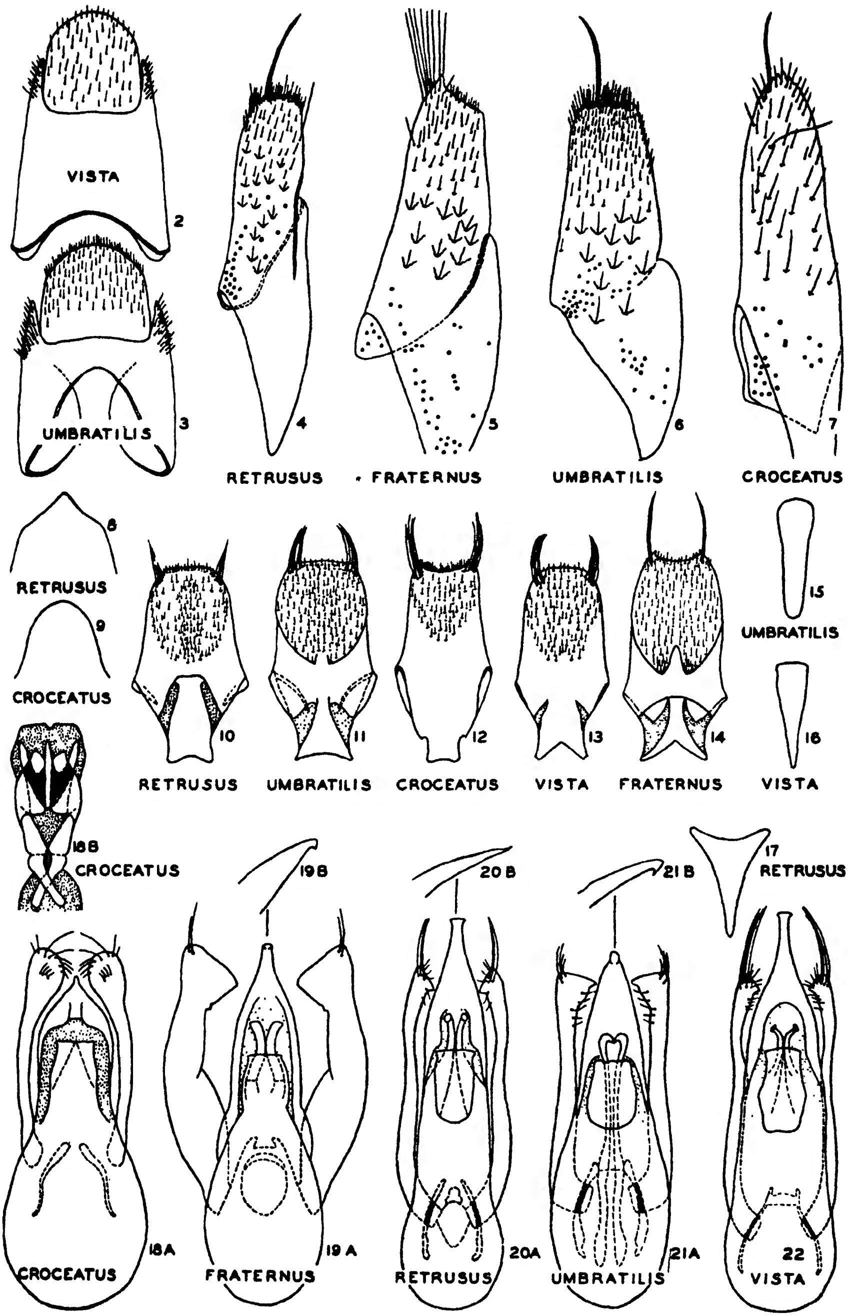
Stenus retrusus Casey, 1884: 154.

From the *umbratilis* complex, *retrusus* and *vista* are distinguished by having the tarsi distinctly lighter than the tibiae. These two species appear to be indistinguishable on the basis of external characters but are satisfactorily differentiated by characters of the male and female genitalia. The male genitalia of *retrusus* have the lateral margins of the opening near the double aedeagal processes distinctly angulate (fig. 20A), and the apical part of the median lobe is comparatively broader than in *vista*. The valvifers of the female (fig. 4) show no significant differences, but the triangular structures lying in the membrane of the genital capsule are distinctive. In *retrusus*, the structure is emarginate on three sides with the posterior margin not less than one-half the total length (fig. 17).

Originally described from one female taken on Vancouver Island, British Columbia. Additional specimens, including males, have been collected as follows: OREGON—Bly Mountains, June 13, 1945, K. M. Fender, mountain meadow; Clear Lake, Mt. Hood National Forest, June 15 and October 7, 1945, K. M. Fender, sweeping in meadow; Elk Lake, July 3, 1938, K. M. Fender; McMinnville, Peavine Ridge, October 15, 1945, K. M. Fender, sweeping reeds and sedges. WASHINGTON—King County, Evans Creek, May 11, 1929, M. H. Hatch; Pierre County, Silver Lake, May 12, 1934, M. H. Hatch; Seattle, April 13, 1932, M. H. Hatch.

EXPLANATION OF PLATE

FIGS. 2 and 3. *Stenus* spp. Ninth tergite of female. FIGS. 4 to 7. *Steuns* spp. Valvifer of female genitalia. FIGS. 8 and 9. *Stenus* spp. Apex of eighth sternite of female. FIGS. 10 to 14. *Stenus* spp. Last sternite of male. FIGS. 15 to 17. *Stenus* spp. Spermatheca. FIGS. 18A and 18B. *Stenus croceatus*. Male genitalia and aedeagus. FIGS. 19 to 22. *Stenus* spp. Male genitalia and lateral aspect of apex of median lobe.


VISTA
2
UMBRATILIS
3
4
RETRUSUS
5
FRATERNUS
6
UMBRATILIS
7
CROCEATUS
8
RETRUSUS
9
CROCEATUS
10
RETRUSUS
11
UMBRATILIS
12
CROCEATUS
13
VISTA
14
FRATERNUS
15
UMBRATILIS
16
VISTA
18B
CROCEATUS
19B
20B
21B
17
RETRUSUS
18A
CROCEATUS
19 A
FRATERNUS
20A
RETRUSUS
21A
UMBRATILIS
22
VISTA

Stenus vista n. sp.

Male.—Length 3 to 4 mm. Body black and somewhat dull above except on the vertex where it is more shining. Antennae and palpi reddish yellow and dusky toward apex. Legs entirely black except the tarsi which are reddish yellow. Posterior margin of eighth sternite triangularly emarginate, the emargination extending for about one-third the length of sternite. Last sternite subtruncate and slightly uneven at apex with a group of several long hairs in posterior lateral region; base Y-shaped (fig. 13), the emargination triangular. Median lobe of genitalia extending beyond lateral lobes, very narrow toward apex and with tip suddenly flared (fig. 22); apical part, in side view, evenly tapered; margin of aedeagal opening straight or nearly so.

Female.—Similar in size and general appearance to male. Eighth sternite angulate on posterior margin as in fig. 8. Valvifer similar to that of *retrusus* (fig. 4). Spermatheca gradually enlarged toward apex of abdomen, sides straight then subparallel in apical one-third.

This species is closely related to *retrusus* Casey, and I have been unable to distinguish them except by the genitalia. As far as the material available for study indicates, the ranges of the two species do not overlap. *S. retrusus* appears to be confined to the Pacific coast region from Oregon to British Columbia.

Holotype, male.—Buena Vista, Colorado, August 4, 1943, H. H. and J. A. Ross, sweeping vegetation at margin of Yale Lake. In collection of Illinois Natural History Survey.

Allotype, female.—Same data as for holotype.

Paratypes.—COLORADO—Buena Vista, August 4, 1943, H. H. and J. A. Ross, 1♂, 1♀. Estes Park, August 27, 1920, H. C. Severin, altitude 8800 feet, 1♂ (South Dakota State College); Electra Lake, June 28 to July 1, 1919, altitude 8400 feet, 1♂ (American Museum). MANITOBA—Churchill, August 18, 1937, W. J. Brown, 3♀ (Canadian National Collection); August 2–9, 1937, D. G. Denning, 1♀ (M. H. Hatch); Churchill River, August 5–6, 1937, D. G. Denning, 1♀ (M. H. Hatch). NORTHWEST TERRITORY—Tununuk, Mackenzie River, August 10, 1930, O. Bryant, Lot. 114, 1♂, 1♀ (C. A. Frost).

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THE TAXONOMY AND BIONOMICS OF A NEW SUBGENUS OF CHIGGER MITES[1]
(Acarina, Trombiculinae)

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The classification of the trombiculine mites has been based primarily on the larval stages, since it is the larvae which are parasitic. The nymphs and adults are relatively difficult to collect and have been little studied. This is unfortunate, since, as more correlations between larvae and adults are made, it becomes apparent that at least in some groups the nymphs and adults offer the most conspicuous generic and specific characters. Considerable confusion in the generic classification will doubtless exist until nymphs or adults are known for all of the named larval genera. Nymphs or adults and larvae are now known for enough species, however, so that some preliminary conclusions concerning the classification can be reached.

APPLICATION OF THE NAME TROMBICULA

The generic name *Trombicula* Berlese (1905) is unfortunately based upon an adult of a Javan species, *T. minor*, not yet known in the larval stage. As shown by Willman (1941) and Ewing (1944) it is a minute species with relatively huge pseudostigmata, with peculiar parallel-sided pedipalpal claws, and with the subapical spines of the pedipalps setiform. It may eventually be shown that some generic name based on larvae is a synonym of *Trombicula* Berlese. In any event, however, the adults of the species whose larvae have usually been placed in the genus *Trombicula* are obviously generically distinct from *Trombicula* Berlese. For this reason *Trombicula* of authors[3] should eventually be called by another name. *Leptotrombidium* Nagayo, Miyakawa, Mitamura, and Imamura is available and might be used for this group. However, the name *Kedania* Kishida, if validly published, has priority over *Leptotrombidium*. Apparently no one in America has seen the paper in which this name was published. Until the validity of *Kedania* can be determined, it seems best to use the name *Trombicula* in its current sense, in order to avoid repeated generic changes.

The following are some of the species which evidently are to be transferred eventually from *Trombicula* to *Leptotrombidium* or *Kedania*: ***akamushi*** Brumpt, ***alleei*** Ewing, ***ardeae*** Trägardh, ***autumnalis*** Shaw, ***blarinae*** Ewing, ***burmensis*** Ewing, ***californica*** Ewing, ***centropodis*** Ewing, ***cervulicola*** Ewing, ***cynictia*** Radford, ***cynos*** Ewing, ***dasyproctae*** Ewing, ***deliensis*** Walch, ***fahrenholzi*** Oudemans, ***fulleri*** Ewing, ***hamertoni*** Radford, ***intermedia*** Nagayo, ***mastomyia*** Radford, ***mexicana*** Ewing, ***microti***

[1]The cost of publishing this article is paid by the Gorgas Memorial Laboratory.—EDITOR.

[2]Now at the American Museum of Natural History, New York City.

[3]According to Ewing (1938) the name *Trombicula* was first applied to larval mites (*akamushi*) by Kitashima and Miyajima (1918).

Ewing, ***muris*** Oudemans, ***nigeriensis*** Ewing, ***oregonensis*** Ewing, ***pallida*** Nagayo, ***palpalis*** Nagayo, ***parkeri*** Radford, ***peromysci*** Ewing, ***peruviana*** Ewing, ***piercei*** Ewing, ***praomyia*** Radford, ***punctata*** Boshell and Kerr, ***rohweri*** Ewing, ***scutellaris*** Nagayo, ***setosa*** Ewing, ***shannoni*** Ewing, ***trägardhi*** Oudemans, ***velascoi*** Boshell and Kerr, ***walchi*** Womersley and Heaslip, ***whartoni*** Ewing.

TROMBICULA AND ITS ALLIES

The majority of the known species of chigger mite larvae belong to a group of genera in which the pseudostigmatic organs of the larvae are not clavate; there are fine setae on the dorsal plate, none of them peculiarly modified; the chelicerae each have a single dorsal tooth; and the pedipalpal claw is bifid or trifid. In the most recent generic classification (Ewing, 1944a) these genera are listed as *Trombicula, Eutrombicula,* and *Acariscus.* The last of these does not appear to differ by any suitable generic character in either larvae or adults from *Eutrombicula,* and has been sunk as a synonym of that genus (Michener, 1946).

Eutrombicula differs from *Trombicula* in having bifid rather than trifid pedipalpal claws in the larvae. It appears to me probable that *Eutrombicula* should be restricted to species having the two points of the claws equal, or the outer (dorsal) longer. Those species, commonly included in *Eutrombicula,* in which the outer prong is slender and shorter than the principal prong are merely species of *Trombicula* in which one of the two small outer prongs has disappeared. Every intergradation is found between three-pronged claws and two-pronged ones of this sort, but I have seen no intergradation between *Eutrombicula* as here restricted and *Trombicula.*

No differences have been observed between adults of *Eutrombicula* and *Trombicula* s. str.,[4] except that eyes are absent in the known adults of the latter group. Apparently they are either present or absent in *Eutrombicula.* There is a group, however, described below as a new subgenus of *Trombicula,* in which the adults are very different. The larvae of this group are indistinguishable from those of *Trombicula,* and it is for this reason only that the new group is not considered a separate genus.

Subgenus **Megatrombicula** nov.

A new subgeneric name, *Megatrombicula,* is proposed for a group of species of *Trombicula* so far known only from tropical America. The characters are indicated in Table I.

Type species: Trombicula alleei Ewing. The new subgenus includes also *T. velascoi* (Boshell and Kerr), *T. peruviana* (Ewing) and *T. attenuata,* new species. It is possible that certain other species, such as *Trombicula hamertoni* (Radford), now known only from larvae, belong to this subgenus.

Adults of the three species of *Megatrombicula* found in Panama also agree in the following features, which may also be found to distinguish

[4]Here as elsewhere in this paper the expression "*Trombicula* s. str." means *Trombicula* in its strict current sense, and refers in no way to the true *Trombicula* Berlese.

the subgenus from *Trombicula* s. str.: Legs and pedipalps with numerous setae; structure of the female genitalia labeled "neck of (?) sacculus" by Ewing (1944a) not visible; lateral margins of penal cone of male with three or four short setae; pseudostigmatic organs simple.

The larvae of *Megatrombicula* agree in the shape of the dorsal plate with those of *Pentagonella* Thor (1936, Zool. Anz., 114: 30), a generic name which has received little attention, possibly because it has been considered a synonym of *Trombicula*. *Pentagonella* was separated from *Trombicula* primarily by the more or less angulate posterior margin of the dorsal plate. Radford (1946, Parasitology, 37: 51) has described the nymph of *Trombicula acuscutellaris* Walch, one of the species included in *Pantagonella*. In this species the pedipalpal tibia is of the usual shape for *Trombicula* s. str. and the eyes, not being mentioned, are assumed to be absent or at least not in an unusual position. It therefore seems reasonable to consider the New World *Megatrombicula* as distinct from the Old World *Pentagonella*, which is probably best considered a synonym of *Trombicula*.

Curiously, for a group in which most species are known only as larvae, all described species of *Megatrombicula* have previously been known only as adults. Perhaps this is because larvae of this subgenus become so much engorged on their hosts that they often make unsatisfactory specimens, and students of this group have hesitated to describe them. Since the larvae of this group are exceedingly similar they are treated separately at the end of this paper.

TABLE I

Megatrombicula, new subgenus	*Trombicula*, s. str.
Adult: Length over 1.5 mm.	*Adult:* Length under 1 mm.
Eyes large and convex, approximately midway between anterior and posterior ends of crista, far anterior to pseudostigmatic area.	Eyes absent (at least in *T. akamushi* and *T. autumnalis*.)
Tibia of pedipalp slender, over three times as long as broad.	Tibia of pedipalp short, robust, less than three times as long as broad.
Sternal plate (between anterior two pairs of coxae) more than twice as broad as long.	Sternal plate not or scarcely broader than long. (?)
Larva: Dorsal abdominal setae (counting marginal ones) twenty-four, arranged as follows: 2-6-6-6-2-2.	*Larva:* Dorsal abdominal setae usually more than thirty.
Deutovum: With several spines in addition to dorsal one.	*Deutovum:* With a single dorsal spine. (?)

KEY TO THE ADULTS OF MEGATROMBICULA

1. Tibia of pedipalp with comb of three spines on inner surface near claw, and usually one other spine.. **2**
   Tibia of pedipalp with eight to seventeen spines on inner surface.... **velascoi**

2. Body hairs with apices almost bare of setulae.................... **peruviana**
   Body hairs plumose throughout length, apices not bare of setulae........... **3**
3. Last segment of front leg parallel sided, more than four times as long as broad, scarcely broader than preceding segment; pedipalpal claw very small, less than one-third as long as finger..................... **attenuata**
   Last segment of front leg of the usual shape, broadest medially, less than three times as long as broad, broader than preceding segment; pedipalpal claw more than one-third as long as finger........................ **alleei**

KEY TO THE KNOWN NYMPHS OF MEGATROMBICULA

1. Tibia of pedipalp with one or two spines on inner surface near apex; hairs of posterior end of body 0.05 to 0.07 mm. long, less than twice as long as those of shoulders.. **alleei**
   Tibia of pedipalp with three to five spines on inner surface near apex; hairs of posterior end of body 0.09 to 0.14 mm. long, two to three times as long as those of shoulders...................................... **velascoi**

Trombicula (Megatrombicula) peruviana Ewing

Trombicula peruviana Ewing, 1926, Ent. News, 37: 112; Ewing, 1931, Proc. U. S. Nat. Mus., 80 (8): 9; Ewing, 1933, Proc. U. S. Nat. Mus., 82 (29): 2.

This species is known from a single adult specimen, now in the United States National Museum, from El Campaniento (probably El Campamento), Peru.

Trombicula (Megatrombicula) alleei Ewing

Trombicula alleei Ewing, 1926, Ent. News, 37: 111; Ewing, 1931, Proc. U. S. Nat. Mus., 80 (8): 6; Ewing, 1933, Proc. U. S. Nat. Mus., 82 (29): 2.

Adult: Length 1.5 to 2.5 mm. Brilliant red in life. Claw of *pedipalp* measured along upper margin 0.30 to 0.36 times length of pedipalpal tibiae; inner surface of tibia with three spines arising from a small projection, and a fourth arising from near upper margin of segment much nearer base; finger of pedipalp with four or five small bristles at apex, setae of finger mostly simple. *Crista* rodlike, expanded gradually to the rear into the triangular pseudostigmatic area, which bears the pseudostigmata at its posterior lateral angles; pseudostigmata simple, about as long as crista. *Body hairs* densely plumose throughout lengths, scarcely longer posteriorly than on shoulders, the longest hairs ranging from 0.07 to 0.16 mm. in length. *Legs* shorter than body or first pair about as long as body, robust; last tarsal segment of anterior leg swollen, broadest near middle, less than three times and sometimes only a little more than twice as long as broad, 1.30 to 1.38 times as long as preceding segment and broader than that segment.

Adults of this species have been collected at Juan Mina, Canal Zone, Panama. Larvae have been found at the same locality; at Gamboa, Canal Zone, Panama; at Santa Rosa, Colon Province, Panama; and at Las Guacas, Panama Province, Panama. The type locality is Barro Colorado Island, Canal Zone, Panama.

The holotype (a male according to a letter from Dr. E. W. Baker) is in the United States National Museum. Dr. G. W. Wharton has kindly compared my specimens with the type and regards them as the same species.

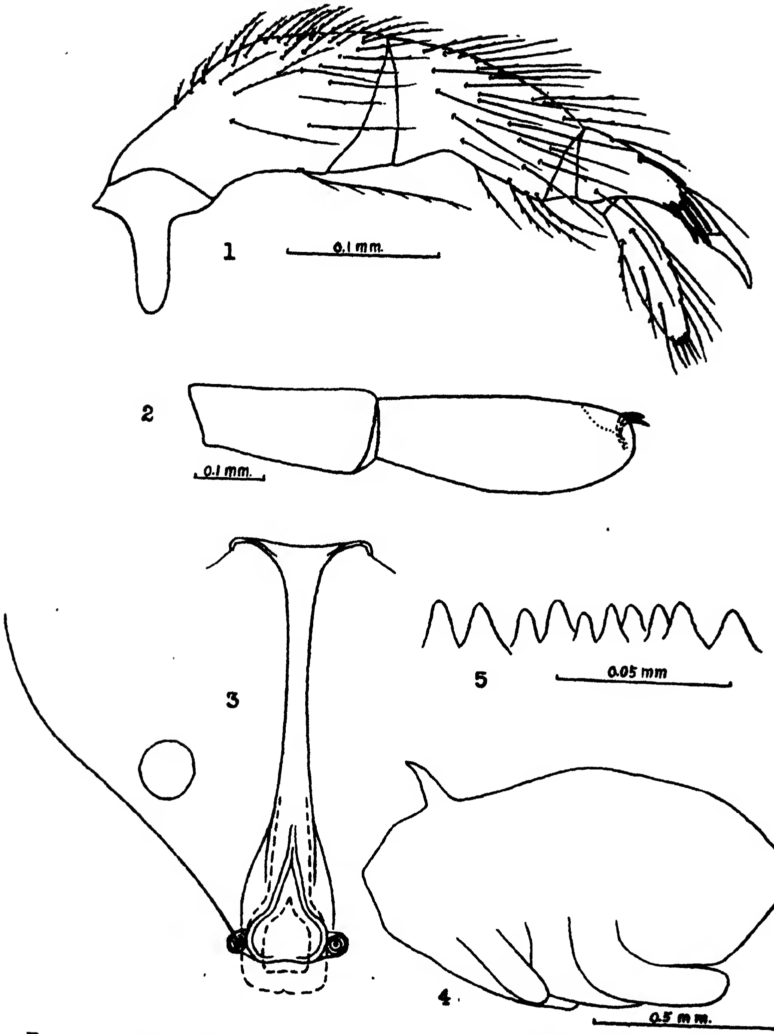


FIG. 1. Lateral view of pedipalp of adult *Trombicula alleei*. 2. Last two segments of foreleg of adult *T. alleei* (Figures 1 and 2 were drawn from small specimens collected on *Pistia* leaves). 3. Crista and associated structures of *T. alleei*. 4. Protonymph of *T. alleei*. 5. Detail of surface sculpture of living protonymph of *T. alleei*.

Great variation in size has been observed in adults of this species and it was at one time believed that the large and small specimens represented two separate species. However, intermediate specimens have been studied, and larvae of the large and small adults appear to be indistinguishable. Since small specimens have been found only on floating plants of *Pistia stratiotes* (a habitat more fully discussed under *T. attenuata*) it is assumed that this habitat is less suitable than the usual terrestrial one.

Egg: Diameter 0.17 to 0.19 mm. Orange, spherical, almost smooth but showing very faint reticulate pattern.

Deutovum: Dorsal median spine not unusually large; each side of body with four large tubercles, two of them tipped with sharp spines (fig. 23); leg sheaths and posterior portion of body smooth, but median portion minutely and rather sparsely tuberculate.

Larva: Described in a subsequent section of this paper.

Protonymph: Dorsal spine unusually long and slender, body surface coarsely tuberculate.

Nymph: Length (when freshly emerged) 1.0 to 1.2 mm. Similar to adult except for usual nymphal characteristics; claw of pedipalp nearly half as long as tibia, which is not so slender as in adult; inner surface of tibia with two, or sometimes only one subapical spine. Body hairs sparser than in adult, those of posterior end of body conspicuously longer than those of shoulders, longest ones 0.05 to 0.07 mm. in length. Legs similar to adult, last segment of foreleg 1.40 to 1.50 times as long as next to last.

Preadult: Similar to protonymph but dorsal spine (in the single specimen studied) not so long.

Bionomics: Adults of this species have been collected at all seasons of the year in wet leafmold close to the shore of the Chagres River at Juan Mina, under aquatic vegetation left stranded on the river banks by receding water, and on floating plants of *Pistia stratiotes* in the Rio Hondo, near Juan Mina. Specimens from the latter habitat were few in number and smaller than the others. It is probable that this is a relatively unsatisfactory habitat. A preadult was found in one of the grooves on the under side of a *Pistia* leaf. An adult was also collected under a rock along a very small stream some distance from the river.

The only eggs studied were laid singly or in twos, threes, or fours on leaves of *Pistia* by specimens collected on this plant. It is possible that larger specimens lay their eggs in masses since some thirty larvae emerged at the same time from wet leaf mold in a rearing jar in which an adult female of this species was kept.

The duration of the egg stage is eight or nine days, and of the deutoval stage about the same.

Larvae have been collected from September through March. They are active, slightly larger on hatching than those of the local species of *Eutrombicula* (i. e., body 0.22 to 0.25 mm. in length), and after engorgement often reach a length of 0.75 mm. It is because of this relatively immense engorgement that freshly emerged nymphs of this species are

larger than the largest adults of such species as ***Eutrombicula batatas*** (Linnaeus).

In contrast to *batatas*, the larvae of *T. alleei* cause a conspicuous local effect on the host. On birds, which are the chief hosts of *T. alleei*, a yellowish swelling forms a ring surrounding each attached larva or group of larvae. This swelling, which is rather hard, doubtless provides considerable protection for the large larvae.

The hosts on which larvae have been collected are listed below. The number following each species is the number of specimens of the host on which larvae of *T. alleei* have been found. Each asterisk (*) indicates a host specimen from which larvae were reared to nymphs and the identification checked by the nymphal characters. As would be expected from the adult habitat, several aquatic and shore birds are included in the list, and most of the terrestrial hosts were from near the shore of the Chagres River. For example, the chickens were feeding in the damp shore vegetation at Juan Mina.

Snake bird, *Anhinga anhinga* (1); little blue heron, *Florida caerulea* (2); American egret, *Casmerodius albus* (1); blue winged teal, *Anas discors* (1); *Buteo*-like hawk (1); domestic chicken, *Gallus gallus* (4); purple gallinule, *Porphyrula martinica* (1); squirrel cuckoo, *Piaya cayana* (1); ani, *Crotophaga ani* (6); massena trogon, *Trogon massena* (1); black-crested ant shrike, *Thamnophilus doliatus* (1); Berlepsch's kingbird, *Tyrannus melancholicus* (1*); Cayenne flycatcher, *Myiozetetes cayanensis* (2); Colombian vermillion-crowned flycatcher, *Myiozetetes similis* (5***); Panama flycatcher, *Myiarchus ferox* (1); Pewee, *Myiochanes* sp.? (1); Galbraith's wren, *Thryothorus leucotis* (1); Prévost's Cacique, *Amblycercus holosericeus* (1); Panama black-headed saltator, *Saltator atriceps* (1); forest rabbit, *Sylvilagus gabbi* (2).

As indicated by the work of Lt. Dale W. Jenkins, larvae drop from chickens for up to seven days after the chickens are caged. Engorged larvae drop within a few hours if the host animal is killed. Placed in jars lined with plaster of Paris, as described (Michener, 1946a) in connection with the rearing of *E. batatas*, they walk about for two or three days and finally become quiescent in a dark hiding place. The protonymph forms within another day or two, the distended larval skin breaking in many places to expose the integument of the protonymph. Larvae which dropped from killed wild birds required from fourteen to sixteen days (or in one instance twenty-one days) after leaving the host until the appearance of the nymph. However, larvae which dropped normally from live chickens required only seven to nine days to transform into nymphs.

In spite of the large size of these mites, adulthood is apparently reached with the same number of molts as in *E. batatas*, there being no additional nymphal or adult stages. No specimen has been reared through the entire life cycle but individual specimens have been observed and appendages measured before and after each molt. The appendages of, for example, a freshly emerged nymph are the same size as those of a nymph about to transform into an adult. The growth which occurs during this as well as other stages involves no molting but merely stretching of the body integument.

Trombicula (Megatrombicula) velascoi Boshell and Kerr

Trombicula velascoi Boshell and Kerr, 1942, Rev. Acad. Colombiana Cien. Exact., Físic Nat., 5: 113.

Adult: Length 1.6 to 2.5 mm. Brilliant red in life. Claw of *pedipalp* measured along upper margin 0.30 to 0.36 times length of pedipalpal tibia; inner surface of tibia with eight to seventeen spines (average of twenty-five specimens 12.1) arranged around lateral and apical margins, those nearest apex consistently present, those nearer base of segment frequently absent, so that the row of spines is sometimes broken by large gaps; sometimes there are one or two spines arising near middle of segment, not in marginal row; finger of pedipalp with five to seven short simple bristles apically, other hairs mostly barbed or plumose. *Crista* and pseudo-stigmatic organs similar to those of *alleei*. *Body hairs* about two-thirds as long on shoulders as on posterior end of body, plumose but the setulae smaller toward apices of hairs and sometimes absent from extreme apices; longest body hairs 0.15 to 0.20 mm. in length. *Legs* shorter than body or first pair as long as body, robust; last tarsal segment of anterior legs somewhat swollen, broadest near middle, slightly less than three times to over four times as long as broad, 1.49 to 1.61 times as long as preceding segment and ordinarily broader than that segment.

This species has been collected at Juan Mina and Chiva Chiva, Canal Zone, Panama; Old Panama, Panama Province, Panama; and Santa Rosa, Colon Province, Panama.

The type locality is Restrepo, Intendencia de Meta, Colombia. It is also known from Villavicencio, Intendencia de Meta and the Municipio de Bolívar, Santander Province, Colombia.

Egg: Unknown.

Deutovum: Unknown.

Larva: Described in a subsequent section of this paper.

Protonymph: Similar to that of *T. alleei*.

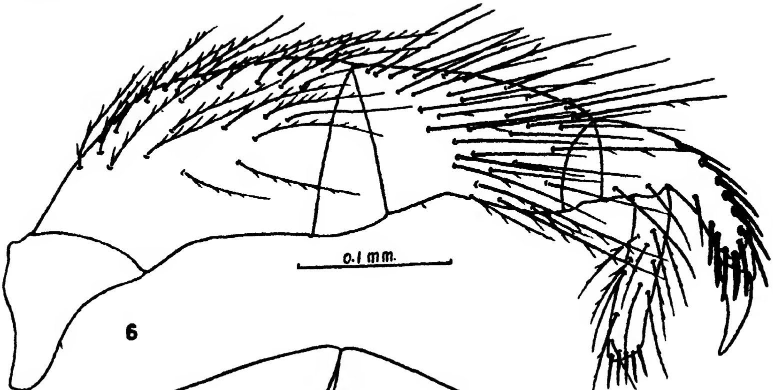
Nymph: Length (when freshly emerged) 0.09 to 1.0 mm. Older nymphs reach 1.5 mm. Similar to adult except for usual nymphal characteristics. Claw of pedipalp sometimes nearly half as long as tibia, which bears three to eight spines on inner surface. Body hairs sparser than in adult, those of posterior end of body two to three times as long as those of shoulders, longest hairs 0.09 to 0.14 mm. in length. Legs similar to adult, last segment of foreleg 1.50 to 1.60 (or in one specimen, perhaps abnormal, 1.75) times length of preceding segment.

Preadult: Unknown.

Bionomics: Adults, and occasionally nymphs, of this species have been collected in nearly every month of the year under stones and logs and in leaf mold, frequently in relatively dry situations, in contrast to the other species discussed in this paper.

EXPLANATION OF PLATE II

FIG. 6. Lateral view of pedipalp of adult *Trombicula velascoi*. 7. Last two segments of foreleg of adult *T. velascoi*. 8. Body hair of adult *T. velascoi*. 9. Lateral view of pedipalp of adult *Trombicula attenuata*. 10. Last two segments of foreleg of adult *T. attenuata*. 11. Body hair of adult *T. attenuata*.



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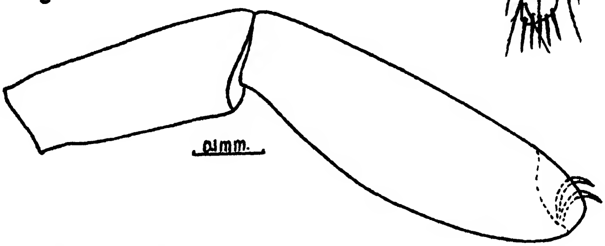

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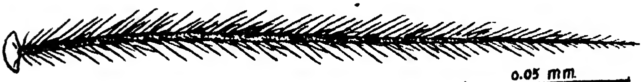

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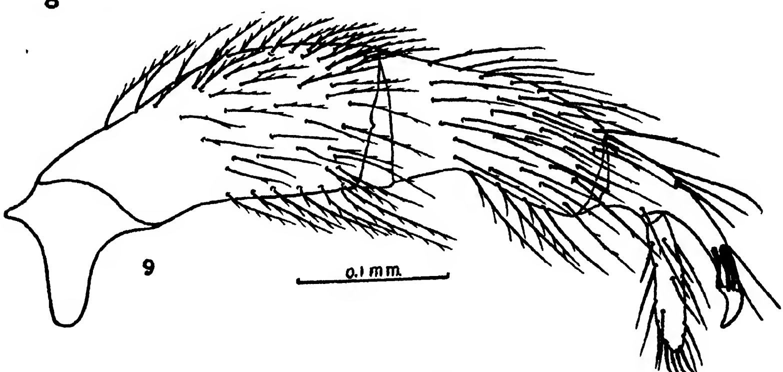

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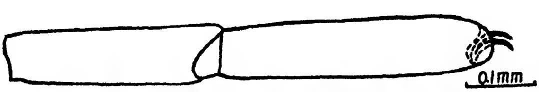

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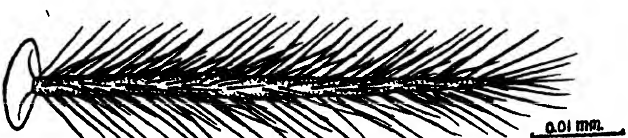

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Eggs have not been seen. However, about forty-five larvae emerged during a two-day period from a jar containing sterilized earth and an adult female of this species.

The larval activity, degree of engorgement, effect on the host of larval attachment, duration of the protonymphal stage, and the number of molts all are described for *T. alleei.*

It is inferred from the numerous arboreal bird hosts that larvae of this species and *T. alleei* regularly climb trees in search of hosts. On one occasion four larvae of *T. velascoi* were collected on branches of a mango tree three to six feet above the ground.

The hosts in which larvae have been collected are listed below. The number following each species is the number of specimens of the host on which larvae of *T. velascoi* have been found. Each asterisk (*) indicates a host specimen from which larvae were reared to nymphs and the identification checked. As would be expected from the habits of the adults, there are no aquatic birds in this list, in contrast to that for *T. alleei.* In spite of the long lists of hosts, the selection of bird hosts does not appear to be completely random. Thus the large number of flycatchers in the accompanying list is not entirely due to the ease with which these birds can be shot. This is shown by the fact that some twenty tanagers of five species have been examined, some from the same trees where infested flycatchers were obtained, yet only one tanager had chiggers on it. Practically every flycatcher obtained had chiggers, either this species or *T. alleei* or both.

Sparrow hawk, ***Falco sparverius*** (1); domestic chicken, ***Gallus gallus*** (1); ani, ***Crotophaga ani*** (8); Rieffer's hummingbird, ***Amazilia tzacatl*** (1); black-breasted puff-bird, ***Notharcus pectoralis*** (1); red-crowned woodpecker, ***Centurus subelegans*** (1); black-crested ant shrike, ***Thamnophilus doliatus*** (2); white-bellied antcatcher, ***Myrmeciza longipes*** (2); Lawrence's woodhewer, ***Xiphorhynchus guttatus*** (2); Berlepsch's kingbird, ***Tyrannus melancholicus*** (8*); Cayenne flycatcher, ***Myiozetetes cayanensis*** (4*); Colombian vermillion-crowned flycatcher, ***Myiozetetes similis*** (13****); gray-capped flycatcher, ***Myiozetetes granadensis*** (2); western lictor flycatcher, ***Pitangus lictor*** (3); Panama flycatcher, ***Myiarchus ferox*** (3); pewee, ***Myiochanes*** sp.? (3); short-legged pewee, ***Myiochanes cinereus*** (1*); a small flycatcher, ***Empidonax*** sp.? (1); northern yellow-bellied elaenia, ***Elaenia flavogaster*** (1); Gould's manakin, ***Manacus vitellinus*** (1); Galbraith's wren, ***Thyrothorus leucotis*** (2); Panama wren, ***Thyrothorus modestus*** (1); Panama house wren, ***Troglodytes musculus*** (1); ocher-fronted hylophilus, ***Hylophilus aurantiifrons*** (1); warbler, ***Dendroica*** sp.? (1); southern dusky-tailed ant tanager, ***Habia gutturalis*** (1); Prevost's cacique, ***Amblycerus holosericeus*** (1); Panama black-headed saltator, ***Saltator atriceps*** (2*); Panama streaked saltator, ***Saltator albicollis*** (1); Hick's seed-eater, ***Sporophila aurita*** (1); Lafresnaye's sparrow, ***Arremonops conirostris*** (3); forest rabbit, ***Sylvilagus gabbi*** (1).

Trombicula (Megatrombicula) attenuata, n. sp.

Adult: Length 2.0 mm. (varying from 1.4 to 2.1 mm. among paratypes). Brilliant red in life. Claw of *pedipalp* measured along upper margin about 0.20 (varying from 0.19 to 0.23) times length of pedipalpal

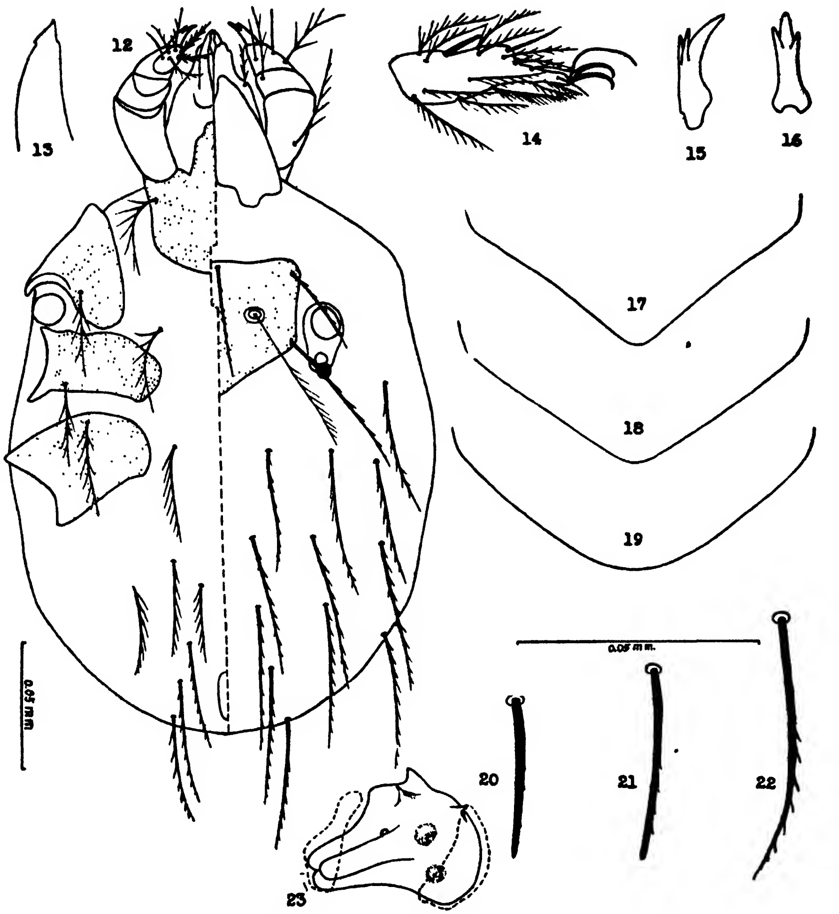

FIG. 12. Larva of *T. attenuata*, dorsal view on right, ventral on left. 13. Apex of chelicera of larval *T. attenuata*. 14. Anterior tarsus of larval *T. attenuata*. 15, 16. Lateral and dorsal view of pedipalpal claw of *T. attenuata*. 17–19. Outlines of posterior portions of dorsal plates of larval *T. attenuata*, *alleei*, and *velascoi*. 20–22. Submedian posterior marginal body hairs of larval *T. velascoi*, *alleei*, and *attenuata*. 23. Lateral view of deutovum of *T. alleei*. Broken lines indicate the position of the halves of the egg shell.

tibia, which is extraordinarily slender; inner surface of tibia with three blunt spines arising near (or basad of) middle of upper margin; finger of pedipalp with four or five short simple bristles apically, other hairs mostly simple. *Crista* about as in other species; pseudostigmatic organs simple, longer than crista. *Body hairs* but little longer at posterior end of body than on shoulders, plumose throughout lengths, longest body hairs 0.13 mm. (longest hairs varying among the paratypes from 0.05 to 0.13 mm.) long. *Legs* slender, anterior pair longer than body, others shorter; last tarsal segment of anterior legs not swollen, not thicker than preceding segment, about parallel sided (sometimes slightly thicker beyond middle or subapically than elsewhere), four and one-half (varying from four to over four and one-half) times as long as broad, 1.20 (1.19 to 1.25) times as long as preceding segment.

Holotype male and *allotype* female: Juan Mina, Canal Zone, Panama, September 12, 1945. Fifty-four adult *paratypes* from the same locality, August 15, September 12, and October 17. The holotype, allotype, and a series of paratypes are in the collection of the American Museum of Natural History, New York City. Additional paratypes will be placed in the collections of the United States National Museum, the Museum of Comparative Zoology, and the Gorgas Memorial Laboratory.

Egg: Diameter 0.16 to 0.18 mm. Red, spherical, smooth.

Deutovum: Similar to that of *T. alleei*.

Larva: Described in a subsequent section of this paper.

Protonymph, *Nymph*, and *Preadult:* Unknown.

Bionomics: This species has thus far been found only on floating plants of water lettuce, *Pistia stratiotes*, a few hundred yards up the Rio Hondo from the point where that stream enters the Chagres River. In this patch of *Pistia* plants it is not uncommon, although less abundant than two species of microtrombidiine mites which also live on *Pistia*. It is much more common than *T. alleei*, found occasionally in the same situation. The mites are found among the coarse hairs and ribs of the under surface of the leaves of the plants.

The eggs are laid in masses of twenty-five to about fifty on the under surface of *Pistia* leaves. The duration of the egg stage is about seven days, that of the deutovum seven to nine days.

Although various birds and mammals were shot near the *Pistia* patch where this species was found, larvae of *attenuata* were not found on any of them and the larval hosts remain uncertain.

A convenient method of handling eggs and deutova of this mite and others inhabiting *Pistia* and similarly moist places has been found and may be worth recording. Individual leaves or pieces of leaves decompose in a few days so that the eggs become imbedded in decomposing material. Keeping eggs on entire plants requires large aquaria and involves the additional disadvantages that unobserved eggs may be present and that when the eggs hatch the larvae will disperse over a large area of leaves and water surface. It was found convenient to place eggs in the middle of a piece of paper fitted into the bottom of a fruit jar. The bottom of the jar is slightly convex inside and a small amount of water is placed in the jar so that only the convex center projects above the water surface. A thin film of water will then extend

over the paper, covering the eggs. The paper can be easily removed from the jar with forceps for microscopic examination of the eggs or deutova, which stick to the paper because of the surface tension of the water. The jar is kept sealed to prevent evaporation of the water as well as the escape of the larvae.

LARVAE OF MEGATROMBICULA

Because of the great similarity of the larvae of the three known species of this subgenus, they are here dealt with in a separate section. All three species agree in the following characters:

Length 0.22 to 0.25 mm. when unengorged, increasing to 0.75 mm. when engorged. Color red. ***Pedipalps*** not strongly elbowed; first, second and third setae plumose, the number of branches varying somewhat but without regard to species, third with from two to six branches, fourth and fifth setae simple; claw of pedipalp slightly shorter than tibia, median prong conspicuously curved, lateral prongs arising about midway the length of claw, relatively straight, shorter and more slender then median prong, the inner prong slightly longer than the outer. ***Chelicerae*** with subapical tooth on convex margin, notch on concave margin; seta of chelicera with one to five branches. ***Dorsal plate*** punctate except for anterior median portion, slightly wider than long, the posterior margin strongly convex or medially angulate, anterior margin slightly concave on either side of median seta; anterior lateral seta about three-fifths as long as posterior lateral; pseudostigmatic organs densely plumose, situated much in front of middle of plate. ***Eyes*** situated close to dorsal plate, the posterior ones small and inconspicuous. ***Body setae*** of dorsum arranged as follows: 2–6–6–6–2–2, the lateral setae of fourth row and both setae of sixth row being marginal; ventral setae, not counting the usual four sternals, twelve. ***Legs*** with coxae (like coxal plate of pedipalps) punctate, the punctures in more or less definite rows; basal spine of last segment of foreleg arising a little more than length of spine from base of segment (this segment frequently more elongate than in fig. 14, there being variation in this character even in larvae from a single egg mass).

The distinctions between the three species of ***Megatrombicula*** known as larvae are very slight in spite of the conspicuous adult characters, and not every larva can be definitely placed in one species or another.

The posterior margin of the dorsal plate is angulate in ***attenuata***, broadly rounded in ***velascoi***, intermediate in ***alleei*** (figs. 17 to 19). Most specimens can be placed on the basis of this character alone, but some are intermediate. In ***attenuata*** the breadth of the dorsal plate is frequently less than in the other species (under 76 microns in ***attenuata***, commonly over 80 in the others), but specimens of ***alleei*** and ***velascoi*** have been found rather frequently with plates as narrow as in ***attenuata***.

The body hairs, including those of the dorsal plate, are longer, with more numerous and longer branches, in ***attenuata*** than in ***velascoi*** (in which the branches of the dorsal body hairs are often nearly wanting), with ***alleei*** occupying an intermediate position (figs. 20 to 22).

This character may be expressed more precisely in several ways. For example, the anterior lateral setae of the dorsal plate reach little

beyond the bases of the posterior lateral setae in *velascoi*, much beyond in *attenuata*. The length of the submedian posterior marginal body setae (sixth row of dorsal setae, as listed in the setal formula in preceding description) has been taken as an index of the length of the body setae. Table II shows frequency distributions of the lengths in microns of these setae in specimens clearly identifiable by the shape of the posterior margin of the dorsal plate. It is evident from this table that *attenuata* is clearly distinguishable from the others by this character, but that *alleei* and *velascoi* overlap broadly. This table has been helpful in identifying many specimens in which the posterior margin of the scutum was not clearly visible or was intermediate between the shapes considered typical for two of the species.

TABLE II

NUMBERS OF INDIVIDUALS OF THREE SPECIES OF *Trombicula* FALLING INTO VARIOUS CLASSES WITH RESPECT TO THE LENGTH OF THE SUBMEDIAN POSTERIOR MARGINAL SETAE

velascoi	5	12	21	12	1	1						
alleei			1	11	7	11	1	3				
attenuata											15	5
Length of hairs (μ)	34–35	36–37	38–39	40–41	42–43	44–45	46–47	48–49	50–51	52–53	54–55	56–57

It is interesting to note that on the basis of known larval characters it would be virtually impossible to determine that *alleei* and *velascoi* are distinct.

ACKNOWLEDGMENTS

The author is much indebted to the Gorgas Memorial Laboratory and especially to its director, Dr. Herbert C. Clark, for excellent facilities provided for this work. The assistance of Henry Van Horn, a Laboratory employee, in obtaining bird and mammal chigger hosts was invaluable. Thanks are also due to Major Marshall Hertig, Sn.C., and Captain G. B. Fairchild, Sn.C., for their assistance and helpful suggestions, and to Mr. Thomas E. Gillard of the American Museum of Natural History for correcting the nomenclature used for the birds.

Special acknowledgment is due to Captain Roy Melvin, Sn.C., who investigated chiggers in Panama prior to my studies and who collected a few of the adults and nearly half of the larvae studied in the preparation of this paper.

The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the Gorgas Memorial Laboratory, Panama City, R. de P.

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TAXONOMIC STUDIES OF NEARCTIC CRYPTINI (ICHNEUMONIDAE, HYMENOPTERA), by HARRY DAVIS PRATT. American Midland Naturalist, Vol. 34, No. 3, pp. 549–661. Notre Dame, Indiana, 1945.

Dr. Pratt's study is an excellent addition to the literature of the parasitic Hymenoptera. He evidently examined an enormous amount of material in the course of his work, and by condensed references he summarizes the location of this material under each species. In the comprehensive treatment of taxonomic data his contribution is scholarly.

With the exception of a brief introduction and a few pages of notes on larvae, including a key to some of the latter as a suggestion of significant characters, the article is wholly taxonomic. The tribe is considered historically and a key to the Nearctic genera is included. Beyond this material the article contains a description of a new genus, *Nasutocryptus*, type *N. nasutus* n. sp., and a key to the Nearctic species of *Cryptus* followed by descriptions of the included species, of which thirty-one are described as new. The plates are made up of excellent figures of wings, genitalia and larval structures with a few other details. A peculiar irregularity is noted in format, in that headings for new species are set in bold-face and those of previously established species in caps and small caps with the exception of a few in bold-face—an item which only an editor might notice. Most entomologists are, no doubt, familiar with the clear and attractive format of the Journal and the excellent quality of the printing.—A. W. L.

LA VIE DES SAUTERELLES, by L. CHOPARD. 204 pages, 15 text figures, 18 half-tone plates. No 6 in a series entitled Histoires Naturelles, published by the Librairie Gallimard, Paris. Price 150 francs.

This attractively written little volume is a companion of *La Vie des Scarabées*, reviewed a year ago, and shares with it the good printing and poor paper of the familiar paper-bound French books. The quality of the plates is reasonably good.

The title is somewhat misleading, since other Orthoptera than the Locustidae are considered, and the earwigs are treated as a group in this order. Contents include chapters on the order in general, on form and habitats, sound, metamorphosis, individual life, reproduction, and relations to man. Like the other books of the series this is a semi-popular work and is an interesting and rewarding volume for anyone who is not a specialist on Orthoptera. It should be a valuable aid to facility in French for anyone interested in insects.—A. W. L.

A NEW GENUS (EXCAVANUS) AND SPECIES OF MEXICAN LEAFHOPPERS RELATED TO ACUNASUS
(Homoptera: Cicadellidae)

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Genus **Excavanus** nov.

Apparently related to *Acunasus* but with a narrower head and a simple type of venation of the fore wing. Vertex short and broad, decidedly narrower than pronotum. Margin thin and foliaceous, disc deeply broadly excavated. Pronotum strongly roundedly produced anteriorly, and strongly, broadly emarginate posteriorly, disc with conspicuous transverse striae. Elytra long and rather narrow, venation simple.

Genotype *Excavanus angustus* n. sp.

Excavanus angustus n. sp.

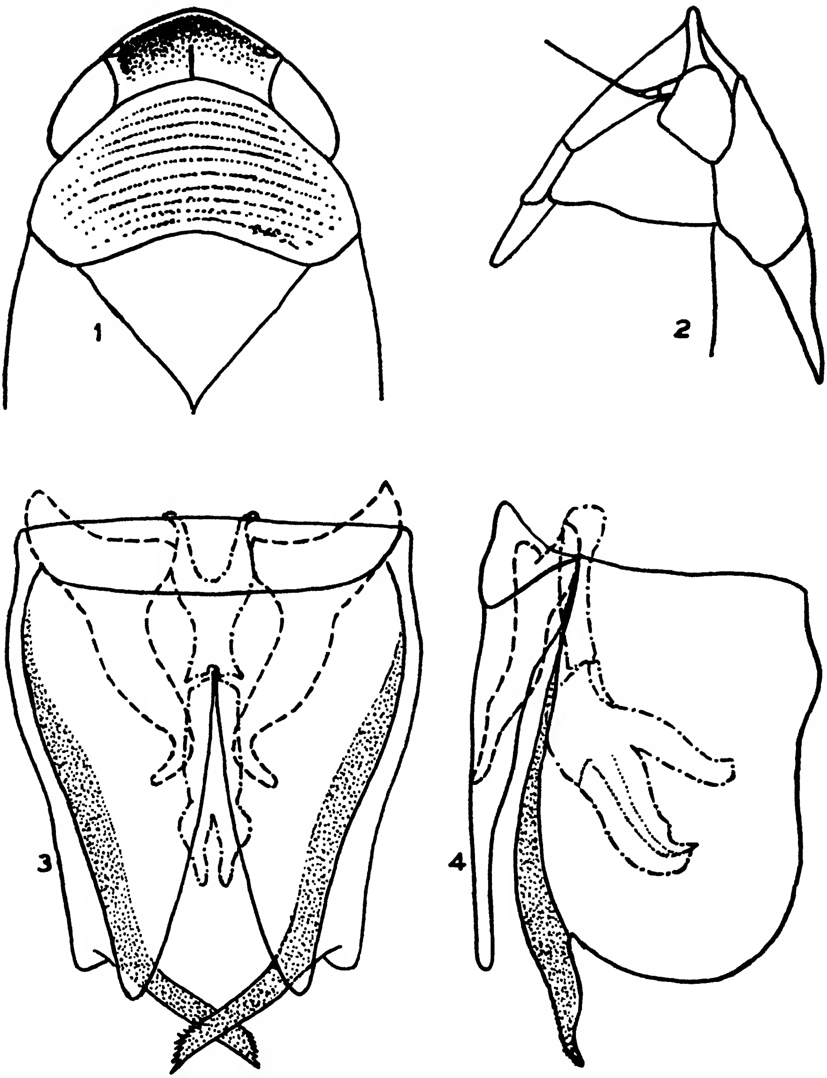
Superficially resembling a narrow species of *Gyponana* but with ocelli on margin of vertex next eyes with excavated vertex disc and distinct genital structures. Length, male, 7.5 mm.

Vertex rather strongly roundedly produced a little longer at middle than next the eyes, two and one-half times as wide between eyes at base as median length. Pronotum decidedly wider than vertex with prominent, angled humeral angles. Scutellum comparatively large with a transverse impressed line on posterior portion of disc. Venation of elytra simple.

Color pale brown with a pair of faint darker spots at apex. Posterior portion of scutellum paler. Face and beneath yellowish.

Genitalia male plates elongate, triangular, apices blunt. Style long, the apex is narrowed and bent outwardly. The aedeagus in ventral view is cleft on apical third. In lateral view it appears in the form of a "V" with a slender anterior arm and a much broader posterior portion. The latter is broadly curved on ventral margin at base and is curved on caudal margin at apex forming a bluntly pointed tip. A long spine arises at base of pygofer on either side and extends along inner margin to apex where it bends upwardly. The inner apical margin is serrate.

Holotype male, collected at Iguala, Gro., October 25, 1941, by E. E. Good and the author. Type in author's collection.



Excavanus angustus n. sp.

FIG. 1. Dorsal view of head and pronotum. 2. Lateral view of head and pronotum. 3. Ventral view of male genitalia. 4. Lateral view of male genitalia.

WAR LOSSES AMONG INSECT COLLECTIONS AND ENTOMOLOGISTS IN JAPAN

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Entomologists carrying on studies including Oriental insects have felt some concern over possible damage to Japanese insect collections, particularly to types. The numerous American entomologists who have corresponded with Japanese specialists and collectors will find useful a report on casualties from war action among entomologists. In October, 1945, the writer participated in early landings by occupying United States troops and during his three months in Sapporo, Hokkaido, was able to assemble information on the extent of destruction to insect collections and casualties among entomologists in Japan, largely through the kind aid of Professor T. Uchida and Dr. C. Watanabe.

I. COLLECTIONS

The three great Japanese insect collections were: (1) the enlarged Matsumura Collection at the Hokkaido Imperial University; (2) the collection built by Professor Esaki at the Kyushu Imperial University; and (3) the collection at the Taihoku Imperial University on Formosa, the fruit of Professor Shiraki's labors. The Hokkaido and Kyushu collections are entirely undamaged and have received continuous care. Because of severance of connections between Japan and Formosa and lack of U. S. troops on that island, it has been difficult to obtain information about the collection at Taihoku. However, it appears that the great Imperial University escaped the heavy bombardment. Through information from a refugee from Formosa, the writer believes that the insect collection came through unharmed. Each of these three important insect collections is accompanied by an extensive library, complete for Japanese publications and with foreign books and journals well represented.

The small, specialized insect collections at the Imperial Universities of Kyoto and Tokyo; the agricultural colleges at Morioka, Tokyo, Miye, Taichu, Ehime, Miyazaki and Hirosaki; and the experiment stations at Kotoni, Sapporo and Tokyo are undamaged. The well-known private collections of Takeuchi, Nawa, H. Kono, Sugitani, and Tosawa escaped destruction.

Thus, most of the insect collections in Japan, with their numerous types, were undamaged. However, there were two notable exceptions, both in Tokyo. Incendiaries completely destroyed the extensive slide collections of parasitic mites and mosquito pupae prepared by Y. Asanuma at the Research Institute of Natural Resources. Few if any types were lost, because Asanuma's studies were in manuscript form, unpublished as a result of discontinuance of entomological periodicals in Japan during the War. The tragedy for Mr. Asanuma is that his manuscripts reporting the results of his researches on rat mites and

mosquito pupae were said to be completely destroyed by the fire. K. Nomura's collection of Lepidoptera was consumed in the same fire.

The other loss to incendiary raids on Tokyo was the collection of the Tokyo College of Agriculture, which contained the large number of aquatic Coleoptera assembled by Dr. K. Kamiya. Dr. J. Linsley Gressitt has informed me that types of aquatic Coleoptera and some Staphylinidae were destroyed with this collection.

No definite information was available as to the condition of the collections of the experiment stations at Taihoku and Tainan on Formosa, or Konuma, Sakhalin. The Formosa collections are with the insect collections at Taihoku Imperial University. They are said to include Dr. Takano's Tachinidae, Dr. Miwa's huge collection of Oriental Elateridae, and numerous other Coleoptera. Loss of these collections with their scores of types would be a blow to entomology in the Orient, but, like the Shiraki collection, all of them are believed safe.

F. G. Werner reports (in litt.) that he visited the Korean national collection in the National Science Museum at Seoul and found it intact. The curator is Pok Seong Cho, formerly of the Nanking Central Museum in China. The Korean Museum contains an excellent butterfly collection. The Forestry Station in Seoul, with a large insect collection, is also unharmed.

The scientific collection of the Central National Museum of Manchukuo at Hsinking contained not only recent insects but a number of fossils. The treatment of the museum at the hands of the Russian occupation forces is unknown.

II. ENTOMOLOGISTS

Among entomologists there were no casualties from the bombing of the Japanese home islands. However, the deaths of three able Japanese entomologists since the outbreak of hostilities should be mentioned.

Dr. J. Shibuya was killed during bombardment of Rota Island in the Marianas. He was a civilian on Rota working in the capacity of an entomologist. He attained high rank among Japanese entomologists for his studies of the moths of the family Pyralidae over many years.

Dr. Y. Niijima, Professor Emeritus of the Hokkaido Imperial University and an authority on Coleoptera and Forest Entomology, passed away quietly on February 6, 1944, at his home in Sapporo.

Dr. M. Matsushita, a specialist on Cerambycidae, passed away on October 10, 1944, at Asahigawa, Hokkaido. Dr. Matsushita was a relatively young man but had been suffering from a serious disease.

Certain entomologists were serving in civilian status in various occupied territories when those places were assaulted and retaken by Allied forces. The fate of these scientists is unknown. Some of them were well known to American entomologists.

Dr. R. Takahashi, whose works on Formosan Aphididae are in many American libraries, was at Kuala Lumpur in Malaya.

A. Kawada, a Japanese Lepidopterist, former entomologist of the Imperial Experiment Station near Tokyo, was on the island of Java.

S. Kato, Assistant Professor of the Peking University, was at Peking, China, at the time of the Japanese surrender.

K. Sato, Hymenopterist and former Assistant of the Division of Japanese and Asiatic Beetles, of the U. S. Bureau of Entomology and Plant Quarantine, was outside of the Japanese home islands, and his present location is unknown.

Five entomologists had been in Manchuria when the Russian armies launched their offensive there, and their fates are unknown. They were K. Oike, student of Cicindellidae; J. Murayama, Ipidae; S. Kariya, Tipulidae, S. Ashina, Odonata, and T. Tsuchiya, Economic Entomology.

I. Okada, specialist in Nematocerous Diptera, especially Mycetophilidae, was entomologist of the Agricultural Experiment Station at Koshurei, Manchukuo. He escaped from there and has returned to Japan.

It was impressed on the writer that the greatest losses to entomology from the devastating raids on Japan were not among the entomologists or the collections, but rather the literature. With few exceptions the countless booksellers and publishers of Tokyo and the smaller cities were burned out completely. However, Dr. J. L. Gressitt reports that Jimbo-cho and Hongo, large bookstores in Tokyo, were not burned, but their stocks are greatly depleted by being bought out. Thousands of books and periodicals were lost and many books once readily obtainable are now rare and cannot be bought for a reasonable price. In the case of books published only a few years ago, the publishers still had large stocks when the fire bombs fell, and most of these stocks were completely destroyed.

PAPÉIS AVULSOS DO DEPARTMENTO DE ZOOLOGIA, VOL. VI. Pages iv+338, 1945. Secretaria da Agricultura, São Paulo, Brazil.

This volume includes twenty-three articles, most of them on insects and many continuing the reports on the fauna of the Monte Alegre district. The exceptions are a short article by C. C. Vieira on mammals, one on birds by Olivério Pinta, five by B. M. Soares on phalangids and one by Otto Schubart on diplopods.

The articles on insects deal with the orders Lepidoptera, Coleoptera, Diptera, Hymenoptera, Orthoptera and Mallophaga. Most of them are lists of species with varying amounts of bibliographic material and annotation. Two by E. Navajas on Elateridae and Fulcidacidae include descriptions of new species, as also do P. J. Moure's article on bees, L. R. Guimarães' article on the biting lice of the tinamous, and Charles P. Alexander's article on Tipulidae. The articles on other arthropods also contain descriptions of new species.

Lauro Travassos' article on the dates of publication of the "Melanges Orthopterologiques" of Henri de Saussure will be of interest to students of that order.

The series of Papéis Avulsos, of which Vol. V is delayed, indicates important progress in the study of the rich Brazilian fauna.—A. W. L.

APOLYSIS, OLIGODRANES AND EMPIDIDEICUS IN AMERICA
(Diptera, Bombyliidae)

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These small flies have had a confused history. In 1886 Bigot described *Rhabdopselaphus mus*, a new genus and species from California, but mistakenly credited it with having three submarginal cells. Williston, in the supplemental notes to his last Manual of Diptera, having examined Bigot's type, announced that the fly has only two submarginals. Coquillett in a series of papers, 1892, 1894 and 1902, published five new species, locating them in the genus *Geron*, and these were removed by Cresson in 1915 to a new genus, *Pseudogeron*, which he was erecting for them and for eight new species from the Southwestern United States. A few months later Cresson announced the identity of *capax*, one of the species described by Coquillett in 1892, with *Rhabdopselaphus mus*, and the synonymy of *Pseudogeron* with *Rhabdopselaphus*.

Rhabdopselaphus was based essentially on having blunt antennae and long slender palpi, thus differing from *Geron*. *Oligodranes*, founded by Loew in 1844, was characterized the same way, the palpi, however, being two-jointed with the apical joint short. There were two original species of *Oligodranes*, from Asia Minor, one with long palpi and the other with short palpi, and in 1875 Loew added a third species, *modestus*, from Turkestan, at the time expressing uncertainty as to the structure of its palpi. Paramonow, in 1929, when adding a Transcaspian species to *Oligodranes*, stated that fresh material of Loew's third species had short single-jointed palpi, and suggested therefore that it be considered as an aberrant species of *Usia*, which belongs to a different subfamily of the Bombyliidae. Recently Engel has described another species from the Caucasus, and decided that Loew's *modestus* is a transitional species between *Usia* and *Oligodranes*. From the point of view of phylogeny it is difficult to visualize how a highly specialized species can be transitional, i.e., ancestral or palingenetic, between groups so diverse as to be given subfamily rank. Hesse had added two more species to *Oligodranes* from South Africa, in which the segmentation of the palpi is scarcely discernible. The American species before me which would be placed in *Rhabdopselaphus* all have single-jointed palpi, though at least in the new species *retrorsus* there is sometimes an indication of segmentation. In length and structure the palpi show extreme variation, ranging from long and thin to very short and stubby.

In 1923 Cole published two species as of *Rhabdopselaphus*, one of which had an open discal cell. He announced that he had another but undescribed species with this same peculiarity. My own collection has eight species with the discal cell open, so the character is not due to individual aberration of the *Rhabdopselaphus* neuration but is validly

phyletic. However, see the remarks on *Apolysis disjuncta* following the description of this insect. The nine American species bear exactly the same relation to the Old World *Apolysis* that *Rhabdopselaphus* does to *Oligodranes*, i.e., one-jointed vs. two-jointed palpi. *Apolysis* was erected by Loew in 1860 for a species which is widely spread in Africa. Two other species of *Apolysis* occur in the Mediterranean region and six more in South Africa. There is no doubt that *Apolysis* is a recent derivative from *Oligodranes*, specialized by the loss of the posterior crossvein, just as the single-jointed palpi of the American species of both genera are to be regarded as reductions from an earlier two-jointed condition.

As to what names to apply to the American species two lines of argument present themselves. (1) If emphasis be placed on the number of segments of the palpi then the Old World genera *Oligodranes* and *Apolysis* are distinct from the New World *Rhabdoselaphus* and an unnamed genus corresponding to *Apolysis*. In that case Paramonow and Engel were justified in removing Loew's third *Oligodranes*, but whether it should go to *Usia*, *Rhabdopselaphus* or to a new genus remains unsettled. (2) If the instability of palpal structure be recognized there appears to be no reason for keeping the American species of *Rhabdopselaphus* distinct from the Old World *Oligodranes*, where they would key in the tables of Schiner, Becker, Verrall, Engel and Hesse, and those species having an open discal cell would all be included in *Apolysis*. Commenting on the number of joints in the palpi of *Gonarthrus* in his exhaustive monograph of South African Bombyliidae, Dr. Hesse has stated that this is not a differentiating generic character in the Bombyliidae, because in many genera species with superficially unjointed palpi show the plane of separation into two segments when treated with caustic potash or creosote.

In as much as generic boundaries are only matters of personal interpretation it appears, in the mind of the present writer, that the simplest expedient is to adopt the second course, and to extend to the American Continent the distribution of *Oligodranes* and *Apolysis*. This decision is supported by the great range of other taxonomic characters in these flies, which makes it difficult to establish generic limits. Much stress has been laid on the development of the "occipital schwielen," a raised longitudinal welt on each side of the neck, and on the depth of the V-shaped groove behind the ocelli. Judged by these characters the species *cinctura* Coquillett with its strong welts should certainly be a *Usia*, though the other species show a complete gradation to an almost smooth occiput, which is the condition of the European *Oligodranes*.

In the Southwestern States there appears to be almost an endless number of species of *Mythicomyia* and of the three genera of this paper. The flies are strictly anthophilous, mostly frequenting arid districts and locally appear to be quite common, though because they include some of the smallest forms of the Bombyliidae they are easily overlooked. The habits of the adults are the same in Europe, Africa and America. Nothing is known of the earlier stages. Collecting in near-by canyons extending along the San Bernardino Mountains and San Jacinto Mountain discloses an isolation that has resulted in the production of

local species, suggesting Gulick's classic illustration of species formation for land snails in the mountain valleys of the Hawaiian Islands. Of the hundreds of California specimens before me it has been difficult to find full agreement with any of the species described from New Mexico. There is only one species with extended distribution, ***sigma***, but as Cresson has suggested, it is not certain that the specimens from Maryland, Florida, Alabama, California and Washington are of monophyletic origin. ***Sigma***, like the other species, exhibits variability, but since the variations are not of tangible specific importance the group must be treated as a single taxonomic species.

The large number of species and their restricted local distribution indicate a youthful group, biologically considered. This is further borne out by the extent of variability often encountered in series of specimens of a kind as well as by the small differences when comparing specimens from several localities. There may be a considerable range in color and in neuration, which must be considered when making identifications from the key and from the descriptions which are based on the type specimen. The exact location of the anterior crossvein, the length and placement of the second submarginal cell, the extent of the second vein, and the proportions of the sections of the fourth and fifth veins are neurational characters not absolutely fixed, yet within limits they are important indices for the placement of species.

Many of the species are markedly dimorphic in the sexes, so that the association of males and females often is dependent on the locality and date labels they bear rather than on a similarity in conformation. To add to the difficulty in making determinations it often happens that color patterns of pollen are completely obscured by greasiness, which also accentuates the yellow fasciae along the abdominal incisures. Contraction of the abdomen upon drying decreases the visible extent of dark bands at the base of the segments and gives the impression that the abdomen as a whole is colored more like the pale apical part of the individual segments. Since color patterns are due mainly to the superficial coat of pollen microscopically slanting in various directions the appearance changes with the angle of view. For best effects the thorax should be viewed from in front and a little to one side, and the abdomen from behind. The important triangle of pollen just above the antennae of the male can give a misleading impression of color if the front is wrinkled on drying. The male genitalia are small and are likely to be twisted, retracted or eviscerated, hence are of little value to the museum taxonomist. But to compensate for the difficulties in making determinations these flies do not possess a coating of easily rubbed tomentum. Even the hairs are not as loosely attached as in other pilose Bombyliidae. The location of abraded hairs is indicated by minute dark dots showing in the pollinose coating.

The following keys, based upon my own collection and the tabulation of ***Pseudogeron*** given by Cresson, appear to be quite workable for most of the specimens before me. Nine of the previously described American species are not represented, but have been included in the keys from data in their diagnoses. How well the tables will serve for collections from other localities remains for the future to determine. Probably in view of the great plasticity of the group very many more

species await discovery and will cause numerous interpolations in the tables. I am withholding a few additional species of *Oligodranes* which I have taken in Southern California, represented only by females, but which lack characters of sufficient taxonomic importance to warrant their announcement at this time. Unless otherwise indicated, the insects described in the following pages were all taken by myself and the types are located in my collection. The collection of the Citrus Experiment Station of the University of California has furnished important data as well as five additional new species. For condensation, in printing, characters enumerated in the tables are not repeated in the diagnoses.

Among the minute Bombyliidae swept from desert flowers are three species unquestionably belonging to the genus *Empidideicus*, which was erected by Becker in 1907 for a species from Tunisia, North Africa. This genus possessed the greatest reduction in neuration in the Bombyliidae, having the auxiliary vein vestigial, the second vein fused with the first, a simple unbranched third vein, the discal cell open due to the loss of the posterior crossvein, and the ambient vein undeveloped.

Other species of *Empidideicus* have since been recorded: *E. hungaricus* Thalhammer, 1911, from Hungary and Corsica; *Efflatouni* Engel, 1933, from Egypt and Turkestan; and *Turneri* Hesse, 1938, from South Africa. Bezzi, in 1926, transferred his *E. nubilis* to *Cyrtosia*, placed his *Glabelula mellea* in *Empidideicus*, and mistakenly removed Brunetti's *E. indicus*, 1917, to *Glabellula*. The net result is that *Empidideicus* now includes one European species, five African, one Indian, and the three American species described herewith.

The relationships of the three genera of this paper to their nearest relatives and to the other Bombyliidae are indicated by the following tabulation.

A. Third vein not forked, therefore one submarginal cell, four posterior cells, anal cell almost always open, no alula.
  B. Second vein short, or imperfect, or wanting; hunchbacked species. (**GLABELLULINAE** Cockerell, 1916) **MYTHICOMYIINAE** Melander, 1902
    C. Second vein vestigial, fused with first, or absent. (If second vein forms a small marginal cell the discal and third posterior cells are confluent). Basal cells nearly equal, ambient vein very weak.[1]
      D. Discal cell fused with third posterior cell.
        E. Anterior ocellus in front of others; abdomen scarcely wider than thorax. (Eur., Asia, Afr. N. Am.)............**Empidideicus** Becker
        EE. Anterior ocellus in line with others; abdomen flattened, wider than thorax. (N. Afr.)........................**Cyrtoides** Engel
      DD. Discal cell complete. (Afr.)...................**Anomaloptilus** Hesse
    CC. Second vein very short but well formed, ending in first vein almost like a crossvein, forming a short triangular marginal cell.
      D. Discal cell complete; male holoptic. (N. and S. Am.), **Mythicomyia** Coquillett
      DD. Discal cell confluent with the large second basal; male dichoptic. (Eur., India., Austr., N. Am.) (*Pachyneres* Greene)..**Glabellula** Bezzi
  BB. Second vein normal, ending independently in costa beyond first vein, therefore marginal cell long, second basal cell usually much shorter than first...**CYRTOSIINAE**

[1]Dr. Hesse has proposed the name *Doliopteryx* for another genus in this group. The description was to appear in the Appendix to Part II of his exhaustive revision of the Bombyliidae of South Africa, but has not yet been published.

C. Discal cell open, no posterior crossvein, second posterior cell pedunculate.
D. Anal cell open, axillar lobe narrow.
E. Second vein ending much closer to first than to third, anterior crossvein beyond middle of wing; proboscis shorter than head (Tasmania)................................**Cyrtomorpha** White
EE. Second vein ending midway between first and third; proboscis as long as head or longer.
F. Head more or less spherical or oval. (S. Eur., W. Asia, N. Afr.) (*Cephalodromia* Becker)........................**Cyrtosia** Perris
FF. Head elongate, occiput large and convex, produced back below. (S. Afr.)..........................**Ceratolaemus Hesse**
DD. Anal cell petiolate, axillar lobe full, second vein ending near first. (S. Afr.)..**Onchopelma** Hesse
CC. Discal cell complete, omitting three veins; male dichoptic.
D. Proboscis as long as head or shorter; first basal cell longer than second. (Eur., W. Asia)........................**Platypygus** Loew
DD. Proboscis longer than head; occiput large, strongly produced posteriorly below. (S. Eur., N. Afr.)...........**Cyrtisiopsis** Seguy
AA. Third vein forked, two submarginal cells, second vein always ending in costa, alula usually lobate. (If three submarginal cells: many genera.)
B. Only three posterior cells. (If abdomen and legs long and slender: **SYSTROPODINAE**.)
C. Third antennal joint blunt with minute sensory thorn or style in a small sulcus above tip; hairs of cheek not curving forward. (If body broad with short abdomen: **USIINAE**)......**PHTHIRIINAE**, part
D. Discal cell complete. (S. Eur., W. Asia, S. Afr., N. Am.) (*Rhabdopselaphus* Bigot, *Pseudogeron* Cresson)...........**Oligodranes** Loew
DD. Discal cell open with second posterior, no posterior crossvein. (S. Eur., W. Asia, Afr., N. Am.)..................**Apolysis** Loew
CC. Third antennal joint long, subulate, pointed, with terminal style; genal hairs curving forward; eighth tergite of female with lappet. (Cosmopolitan.) (*Empidigeron* Painter.) **GERONINAE. Geron** Meigen
BB. Four posterior cells; many genera.

KEY TO THE AMERICAN SPECIES OF EMPIDIDEICUS

1. Second vein vestigial, no marginal cell, basal cells coextensive, veins largely thin and pale, anal lobe wider than anal cell; tibiae and knees yellow; no yellow spot above front coxae..2
Second vein distinct, curving to meet the first vein, second basal cell shorter than first basal, veins black, anal lobe no wider than anal cell; legs black; a conspicuous bright yellow spot above front coxae, as well as humeri and postalar callosities bright yellow. (Cal.)...................**propleuralis**
2. Scutellum and a large apical dorsal spot on abdomen luteous; sides of thorax yellow from humeri to postalar callosities. (Cal.)..........**scutellaris**
Scutellum black, abdomen black with the incisures narrowly yellow; humeri and notopleural suture yellow (male), or humeri, broad notopleural mark and postalar callosities yellow (female). (Cal., Ariz.)............**humeralis**

Empidideicus humeralis n. sp.

Male.—Length 1.35 mm. Face very small, the mouth-opening excavated almost to the antennae, the narrow orbits and cheeks shining black and bare; occiput quite bare, shining below; eyes contiguous all along the front, the facets of upper two-thirds scarcely larger than the lower ones; antennae apparently two-jointed, the basal joint minute, the apical joint short-ovate, scarcely longer than wide, style thick, as long as the apical joint and tipped with a thin section; proboscis as long as head, oblique, thick, palpi not visible. Thorax shining black, the humeri white, very thinly cinereous dusted on sides and pleura, bare

except for a few microscopic hairs about shoulders and on dorsocentral rows, notopleural suture very narrowly yellow. Abdomen black, the side and posterior margins of the segments very narrowly yellowish, hairs white; two dorsal digitate valves overlapping the open pygidium. Knees, tibiae and base of metatarsi pale yellow, femora otherwise black, tarsi piceous. Wings whitish hyaline, anal lobe full, semicircular, veins pale, the third and sixth veins and crossveins strongest, ambient vein very weak, auxiliary vein thin and barely attaining costa, second vein wanting, indicated by a pale yellowish coloring adjacent to first vein, petiole of fourth vein a little shorter than second posterior cell which is not wider than first or third on margin, anal cell widely open; halteres white, the base of the stalk fuscous.

Female.—Front one-half longer than wide and with a pair of confluent yellow spots above antennae; face yellowish immediately below antennae, half as long as front. Sides of mesonotum in front of transverse suture and the posterior calli yellow. Basal segments of abdomen wholly black, last ventral segments swollen. Anal lobe of wing smaller than in male.

Holotype and allotype.—Tahquitz Canyon, near Palm Springs, California, 23 April, 1944. *Paratypes*—A male and a female, 24 March 1935, and two males and three females 10 April, 1946, also from Palm Springs; a male, Sheep Creek Canyon, near Phelan, California, 24 May, 1945; and a female, Wellton, Arizona, 6 April, 1935.

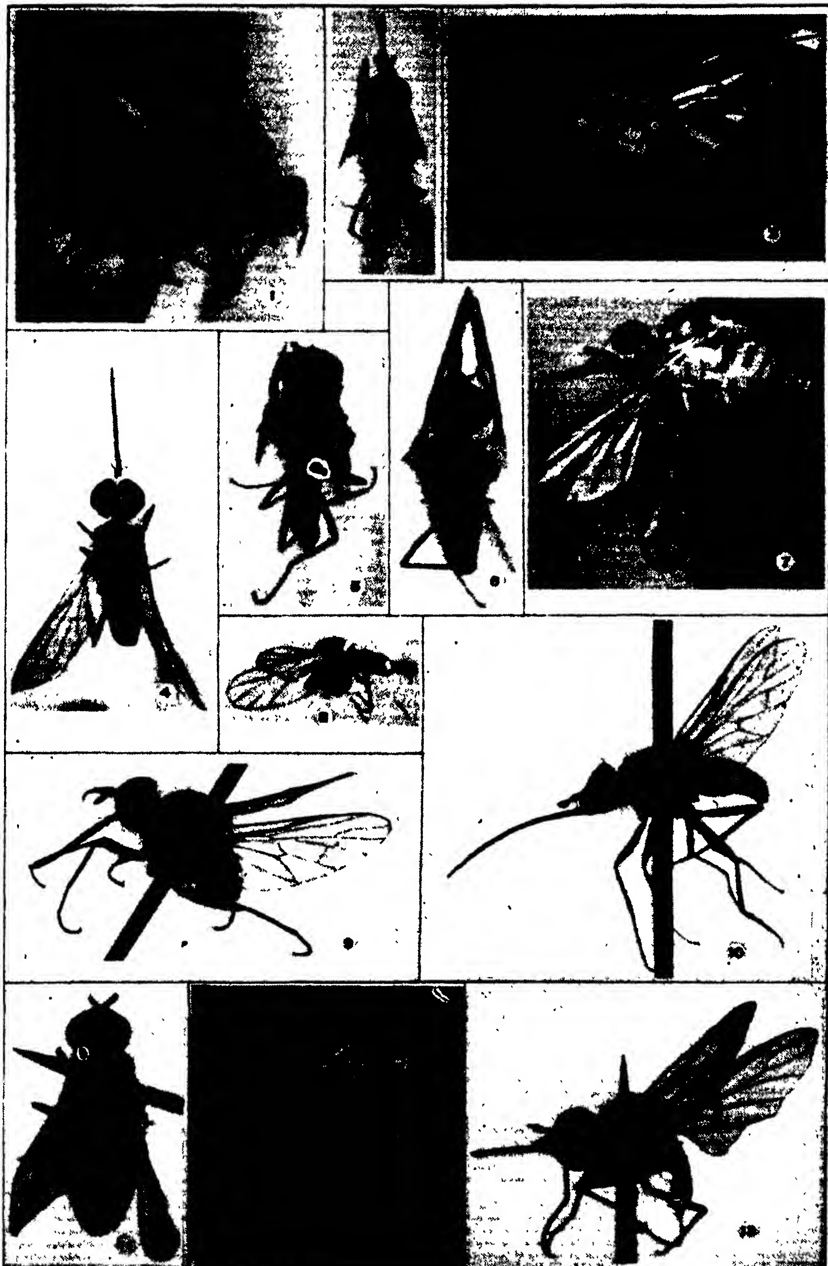
Empidideicus scutellaris, n. sp.

Figure 8

Length 1.2 mm. Head shining black, front broad, transversely yellow above antennae, widened behind, at front ocellus as wide as long and equalling the width of an eye, face yellow, vertical, the central part above the small mouth-opening as long as front, cheeks horizontal, occiput bulbous and without weals. Antennae as in *humeralis*, proboscis about half as long as head-height. Thorax with scattered microscopic hairs, the humeri and sides both above and below the notopleural suture to the transverse suture and below the notopleural line to base of wing bright yellow, postalar calli narrowly yellow; mesopleura and pteropleura polished; scutellum black at very base. Abdomen nearly bare, shining black, side membranes yellow, the luteous apical spot rounded and extending over last four segments; genitalia inflexed under abdomen, longitudinally sulcate. Apical third of femora and all of tibiae and metatarsi yellow. Wings hyaline, venation as in *humeralis* but the fourth vein transparent from anterior crossvein to middle of second posterior cell, auxiliary vein absent, second vein fused with the swollen flavous end of first vein; halteres completely flavous.

EXPLANATION OF PLATE I

FIG. 1, *Oligodranes maculatus*, n. sp., female; 2, *longirostris*, n. sp., male; 3, *comosus*, n. sp., female; 4, *sipho*, n. sp., male; 5, *pulcher*, n. sp., male; 6, *loricatus*, n. sp., male; 7, *togatus*, n. sp., female; 8, *Empidideicus scutellatus*, n. sp.; 9, *Oligodranes lasius*, n. sp., male; 10, *cinctura* Coquillett, male; 11, *trifidus*, n. sp., female; 12, *retrorsus*, n. sp., female; 13, *Apolysis druias*, n. sp., male.



Types.—Three specimens taken 12 May, 1944, by sweeping flowers at the base of Piute Butte in Western Mojave Desert, California.

Were it not that the Old World species of *Empidideicus* have dichoptic males the present specimens would be supposed to be females. The structure of the abdominal terminalia is difficult to understand, being unlike that of either sex of *humeralis.*

Empidideicus propleuralis, n. sp.

Length 1.4 mm. Shining black, the thorax marked with conspicuous light-yellow spots covering the humeri, postalar callosities, propleura and upper edge of the sternopleura and pteropleura. A pair of vertical spots on lower front and the face luteous; antennae as in *humeralis:* proboscis slightly shorter than head. Scutellum with six minute marginal hairs. Abdominal incisures very narrowly whitish, vestiture microscopic and brownish. Wings hyaline, the first, third and sixth veins strongest, anal lobe obtusely rounding, second basal cell shorter than the first by the length of the anterior crossvein, auxiliary vein firm but evanescent at three-fifths the length of the costal cell, second vein swinging free from the first to end in the latter before its tip, last section of fourth vein arching forward, the second posterior cell wider on the margin than either the first or third posterior cells; knob of halteres large and almost white.

Types.—Three specimens, collected 16 June, 1945, near the junction of the South and East Forks of the Santa Ana River, in the San Bernardino Mountains, California, elevation 6250 feet.

The arrangement of the second vein to form a small marginal cell is much like that of *Mythicomyia* and probably indicates a closer relationship with that genus than the open discal cell does with *Empidideicus.* It would seem then that *Empidideicus* is a polyphyletic artificial genus, but it is more expedient to place *propleuralis* here than to erect a new genus for it.

KEY TO THE AMERICAN SPECIES OF APOLYSIS

1. Body black, more or less shining..2
   Body opaque or pollinose; second submarginal cell about as long as its petiole..4
2. Body shining or subshining black; veins dark. (Cal.)..............**disjuncta**
   Body glistening black; veins pale..3
3. Anterior branch of third vein at wing-tip, last two sections of third vein of male proportioned about 3 : 1, of female 3 : 2, second vein of male ending opposite basal fourth of second submarginal cell, of female at basal third; 1.4 mm. (Cal.)..**petiolata**
   Posterior branch of third vein ending at wing-tip, last two sections of third vein of male proportioned about 3 : 2, second vein ending near basal third of second submarginal cell; 0.75 mm. (Cal.)..............**minutissima**
4. Thorax of male silvery gray pollinose, abdomen densely cinereous; legs black except knees, base of tibiae and base of metatarsi yellowish; 1.2 mm. (L. Cal.)..**pygmaea** Cole
   Thorax not silvery gray pollinose, if cinereous the abdomen is flavous or the tarsi all black..5
5. Ambient vein stopping abruptly at fifth vein, first basal cell distinctly longer than second; thorax cinereous, nearly or quite bare species. (If ambient vein is complete, abdomen of female mostly yellow and legs black, see *Oligodranes instabilis*)..6

Ambient vein continuing beyond fifth vein though weak, basal cells of same length; thorax of male opaque black with cinereous markings in front, abdomen and legs black; face, cheeks, body and femora loosely pilose. (*druias* female: thorax vittate and maculate, abdomen opaque black with white fasciae) 8

6. Abdomen of female black in ground color, heavily cinereous, incisures white; tibiae black except extreme base; 3 mm. (Cal.) .... **glauca**
Abdomen of female yellowish; anterior tibiae yellowish; less than 2 mm. 7

7. Petiole of anal cell as long as the cubital vein closing it; 1.5 mm. (Cal.), **timberlakei**
Petiole of anal cell half as long as the cubital vein closing it; 1.8 mm. (Cal.) .... **mohavea**

8. Anal cell closed and petiolate; third antennal joint deeply excised above tip and with an obliquely upright thorn; 2 mm. (Cal.) .... **druias**
Anal cell barely closed in the margin and not petiolate; third antennal joint only somewhat obliquely truncate above tip, thorn invisible; 2.3 mm. (Cal.) .... **aperta**

Apolysis aperta, n. sp.

Male.—Length 2.3 mm. Body wholly black, not shining, loosely but conspicuously white-pilose, the hairs longest on underside of the head. First antennal joint one-half longer than the second, third one-half longer than the basal two together, elongate oboval, widest slightly beyond the middle; rounded at tip, the pit shallow and circular, thorn microscopic; proboscis straight, porrect, twice the head-height, palpi very thin, black, extending along one-fourth of the proboscis. Apical segments of abdomen thinly dark cinereous, no indications of fasciae, terminal pygidial valves pale. Knees very narrowly fuscous. Wings hyaline, veins all dark, costal cell grayish, second submarginal cell about three times as long as apical width, second vein ending at about two-thirds the second submarginal cell, the first vein ending opposite its base, last two sections of third vein proportioned 3 : 2, the anterior branch ending at wing-tip, last two sections of fourth vein 1 : 9; stalk and base of knob of halteres yellow, the remainder blackish.

Holotype.—Mountain Home, California, in the foothills of the San Bernardino Mountains, 21 September, 1944.

Apolysis disjuncta, n. sp.

Male.—Length 1.4 mm. Body and legs wholly black, shining but not glistening; knob of halteres white. Frontal triangle black, face with a full row of six hairs, continuing on the cheeks, occiput almost bare; basal joints of antennae equal and globular, third joint elliptical, 2.5 times as long as deep, with preapical notch and microscopic thorn; proboscis about equal to head-height, straight, porrect and thick, palpi about one-fourth the proboscis. Hairs rather numerous at sides of thorax, of holotype black (pale in specimens from Cajon Pass). Vestiture of abdomen moderately sparse, of nearly uniform length; pygidium with a pair of elongate triangular ventral valves. Hairs of legs sparse, but those of femora and the extensor ones of hind tibiae longer than the width of their joints. Wings hyaline, the marginal cell grayish, veins blackish to root of wing, basal cells coextensive, second submarginal cell subequal to its petiole or slightly shorter, third vein ending beyond wing-tip, anal petiole longer than anterior crossvein, ambient vein complete, thin but distinct.

Female.—Front square, with a transverse indentation at middle, occipital weals undeveloped; incisures of segments three, four and five very narrowly whitish; hairs of body sparse and pale.

Holotype and allotype.—Sheep Creek Canyon, about four miles south of Phelan, San Barnardino County, California, 24 May, 1945. *Paratypes.*—One male taken with the types, two males from Cajon, California, 28 June, 1945, and two females from the eastern end of Barton Flats, San Bernardino Mountains, California, 16 June, 1945. The species name refers to the occasional presence of the posterior crossvein.

In addition to the type species, which classify as truly belonging to *Apolysis*, there are four specimens taken with the others that are puzzling. A male from Barton Flats and a female from Sheep Creek Canyon have the discal cell complete in the right wing but open in the left, and a male and a female from Sheep Creek Canyon have the discal cell complete in both wings, just as in *Oligodranes*. I conclude that these are aberrant specimens showing reversions to the ancestral neuration, a condition which could be possible in a nepionic genus.

Apolysis druias, n. sp.

Figure 13

Male.—Length 2 mm. Opaque black, the front edge of thorax ornate with white-cinereous dense coating, venter and pleurae dull cinereous, legs wholly black; pile long and white, except on back of head. Ocellar triangle black, front and face silvery white, occiput flattened, black, its hairs black; third antennal joint elliptical or elongate pyriform, 2.5 to 3 times as long as deep, the notch and thorn distinct; proboscis 1.25 times the head-height, slight curving toward tip, palpi one-fifth as long as proboscis, black. Front edge of thorax broadly cinereous, extending widely on sides to root of wing and following up transverse suture almost to a bifid median cinereous vitta, which may be confluent in front with the shoulder pattern, or may be set off by thin incursions of the black of the disk. Tergites of abdomen laterally with indication of cinereous tone, sternites with incisures narrowly yellow; pygidium pear-shaped in profile, base with an uncinate process on each side. Wings hyaline, veins blackish to base, sections of third vein proportioned 6 : 5 or subequal, the anterior branch ending at tip of wing, petiole of anal cell longer than anterior crossvein; root of halteres black, knob whitish.

Female.—All hairs white and short. Head, pleurae and venter densely cinereous, mesonotum maculate, tergites strikingly fasciate. Vertex and upper occiput sometimes brownish; front 1.3 times as long as width at antennae, narrowed behind, with scattered porrect hairs; occiput somewhat convex, the weals distinct and meeting below. Mesonotum tricolored, the front edge, sides and two anterior vittae light cinereous, a long narrow median stripe, two prominent sublateral spots and a smaller supra-alar spot black or blackish, the posterior portion, scutellum and forward extensions bounding the cinereous vittae olivaceous brown.

Types.—Thirty-five males and twenty-three females, collected from the small white flowers of a *Phacelia* at Oak Grove on the north side

of Palomar Mountain, San Diego County, California, 8 May, 1945; a male and a female from Oak Glen, 2 July, 1945; and three males and five females from the same white *Phacelia* at Verdemont, 24 May, 1945 and 25 April, 1946, the last two localities in San Bernardino County, California. The species name is selected in commemoration of the Druids who also frequented oak groves.

In the Citrus Experiment Station are three males and four females, collected by Professor P. H. Timberlake, at Riverside, California, 2 to 10 May, 1937, and at Warner Hot Springs, California, 9 May, 1936. The flies were taken from flowers of *Cryptantha intermedia* and *Eriophyllum confertiflorum*.

Apolysis glauca, n. sp.

Female.—Length 3 mm. Ground color black, thickly covered with light gray pollen. Vertex and occiput pilose with short white hairs, longer below, face with a row of short white hairs; antennae cinereous, basal joints equal, shorter than wide, the third joint slightly more than twice the basals, deepest at two-thirds and three times as long as deep, style distinct, inserted at upper apex of the third joint; proboscis twice as long as head-height, palpi one-fifth as long as proboscis. Thorax with an indication of a pair of darker median vittae, disappearing posteriorly, dorsum nearly bare, the hairs very short, white, most evident about humeri, notopleural region and apex of scutellum. Abdominal incisures very narrowly white, segments two to six on each side with a sublateral black oval spot, sternites with corresponding but smaller spots; hairs of abdomen short and white, more noticeable than on thorax. Legs lightly cinereous, black except the tip of femora and extreme base of tibiae, which are yellowish; hairs very short, pale, abundant but not conspicuous. Wings hyaline, whitish at base, veins largely pale yellow at base, distally brownish, stigma filling marginal cell, yellowish, first basal cell noticeably longer than second, sections of third vein equal, the anterior branch ending at wing-tip, section of fourth vein 1 : 7, petiole of anal cell fully half the length of the cubital vein closing the cell; halteres and alulae white.

Holotype.—Magnesium Springs Canyon, about half way between Palm Springs and Indio, California, 5 April, 1945.

Apolysis minutissima, n. sp.

Male.—Length 0.75 mm. Shining black, with halteres yellowish white, practically devoid of hair. Upper facets coarse, occupying about two-thirds of the eye, the lower facets contrastingly minute; basal joints of antennae minute, third joint broadly elliptical, about three times as long as the basal two and twice as long as wide; proboscis shorter than head-height, palpi not visible. Thoracic hairs scattering and short, but arranged in three longitudinal rows on back; scutellum prominent, almost hemispherical, with four small pale hairs. Tibiae and tarsi fuscous. Wings hyaline, stigma very weak, veins delicate, scarcely paler at base, ambient vein very thin beyond wing-tip, sections of fourth vein proportioned about 1 : 10, petiole of anal cell one-third the length of the cubital vein closing the cell.

Holotype.—29 Palms, California, 28 August, 1934 (P. H. Timberlake). This species is so different from *A. timberlakei*, which was taken at the same time, that it is probable they are distinct, instead of representing the two sexes of extreme dimorphism.

Apolysis mohavea, n. sp.

Female.—Length 1.8 mm. Head and thorax cinereous, abdomen yellowish. Sides of face fringed with short hairs; first antennal joint minute, second globular, third twice the length of the basals combined, broadly elliptical, plainly notched above the apex, scarcely twice as long as deep; proboscis one and one-half times the head-height, palpi thin, one-third the length of the proboscis. Dorsum of thorax almost bare, the sparse dorsocentrals and acrostichal hairs minute, scutellum with six minute hairs. Femora cinereous, anterior tibiae yellowish, all tarsi black. Wings hyaline, veins of basal half pale yellowish, stigma very weak, yellowish, second submarginal cell three times as long as wide, the first vein ending opposite its beginning, the second vein before its middle, sections of fourth vein proportioned 1 : 8; halteres yellowish white.

Holotype.—On desert flowers, base of Piute Butte, Mojave Desert, California, 12 May, 1944. *Paratype.*—One female, same locality, 24 April, 1946.

Apolysis petiolata, n. sp.

Male.—Length 1.4 mm. Body shining black over all, the knob of the halteres white, third antennal joint opaque. Face with two microscopic hairs under the antennae; occipital hairs extremely sparse and short; upper facets moderate; antennae with first joint shorter than the globular second, third joint one and two-thirds the length of the basal two, bluntly elliptical, twice as long as deep; proboscis but slightly longer than head-height, straight and slender, palpi one-fourth as long as the proboscis. Mesonotum glabrous except for a few pale hairs above the notopleural suture, scutellum bearing four minute hairs. Each of the last three abdominal segments with a sparse transverse row of minute hairs. Legs with microscopic hairs, only subshining. Wings hyaline, costa vanishing beyond the wing-tip, veins delicate, basal and posterior veins almost uncolored, stigma very weak, sections of fourth vein proportioned 1 : 7; petiole of anal cell about half the length of the cubital vein closing the cell.

Female.—Differs in the longer second marginal cell as indicated in the key, veins black to root of wing, sections of fourth vein about 1 : 8.

Holotype.—Swept from desert flowers at the base of Piute Butte, Mojave Desert, California, 12 May, 1944. The species is remarkable in the long petiole of the second submarginal cell of the male. *Allotype* female: Magnesium Springs Canyon, near Indio, California, 5 April, 1945. *Paratypes.*—One female, same locality as allotype, 4 April, 1946; one female, Andreas Canyon, near Palm Springs, California, 15 May, 1932, collected by P. H. Timberlake on *Eriodictyon crassifolium* (C. E. S.).

Apolysis timberlakei, n. sp.

Female.—Length 1.3 mm. Head and thorax cinereous, almost silvery pruinose, bare. Basal joints of antennae very small, cinereous, third joint nearly twice the length of the basals combined, bluntly elliptical, about twice as long as deep; proboscis twice the head-height, palpi one-fourth the length of the proboscis. Abdomen pale yellow. Femora cinereous, anterior tibiae and metatarsi yellowish brown. Wings hyaline, veins on basal half pale yellowish, second submarginal cell three times as long as wide, the first vein ending opposite its base, the second vein at the middle of the cell, sections of fourth vein proportioned 1 : 9; halteres pale yellowish white.

Holotype.—29 Palms, California, 28 August, 1934 (P. H. Timberlake).

A female from Palm Springs, 18 November, 1943, is apparently the same species, but its proboscis and palpi are shorter, and the tarsi are darker. It measures 1.65 mm.

KEY TO THE AMERICAN SPECIES OF OLIGODRANES

1. First antennal joint about three times as long as second, provided with hairs above and below; occiput of female with very strong vertical weals on each side of neck; robust, mostly shining; abdomen of male opaque; pilose, male with abundant black pile on propleura and usually on face and occiput; abdomen with yellow fasciae; proboscis strongly arched; posterior crossvein of male rather straight but oblique to fifth vein, of female sinuous; 5 mm. (*cinctura*) 2
   First antennal joint never more than twice as long as second, never provided with hair below and rarely above; occipital weals and central groove less pronounced, or undeveloped 3
2. Second submarginal cell at least three times as long as apical width, anterior branch of third vein ending at wing-tip; female typically with three broad thinly cinereous notal vittae. (Cal., Wash., Ida.), **cinctura** Coquillett
   Second submarginal cell scarcely twice as long as wide, the anterior branch of third vein sinuously curving forward to end much before wing-tip; disc of notum of both sexes uniformly shining. (Cal., Wash.), **setosus** Cresson
3. Posterior crossvein more or less sinuous and oblique 4
   Posterior crossvein straight or very slightly arched and about at right angles to third and fourth veins 8
4. Face pilose; anterior crossvein nearly at or beyond middle of discal cell; thorax and abdomen opaque densely cinereous in part; proboscis long and curved. (If mesonotum of male is black with pronounced cinereous shoulder triangles, see *lasius*, couplet 33; if body is very pilose and wholly cinereous, see *comosus*, couplet 15.) 5
   Face bare below antennae, sometimes with hairs near cheeks; anterior crossvein normally near basal third of discal cell; proboscis 1.5 to 2 times head-height 6
5. Mesonotum densely and uniformly cinereous except for four small glistening black spots transversely placed near suture; abdomen cinereous, hind margins of segments showing yellowish-white ground-color; knees testaceous; 4.75 mm. (Cal.) .... **speculifer**
   Male: the cinereous mesonotum with four heavy opaque black vittae; base of abdominal segments black. Female: vittae less intense and the black fasciae narrow; legs black. (Cal., Ariz., N. Mex., Tex.) .. **trochilus** Coquillett
6. Palpi about half as long as proboscis; no sagittal brown line between the median vittae of female 7
   Palpi about one-sixth the length of proboscis; notum of male black with dull cinereous markings at shoulders, sides and a prescutellar pair; female notum with five brown vittae; front of female brown longer than wide, of male satiny brown; 3 mm. (Cal.) .... **montanus**

7. Hairs sparse and white; notum of male brown, of female centrally brown and anteriorly bivittate; abdomen cinereous with base of segments darker; 6 mm. (Cal.) (*capax* Coquillett.) (If front part of mesonotum is heavily cinereous pruinose, see *togatus*, couplet 36).......... **mus** Bigot
Hairs of occiput and thorax of male abundant, long and dark, of female sparse and pale; dorsum of thorax and abdomen of male deep velvet black, usually with two triangular dark cinereous marks on front edge of thorax; notum and abdomen of female brownish black, usually with shoulders and scutellum cinereous, sometimes with incisures yellow; 3–5 mm. (Cal., Oreg., Wash., Ida., Mont., Ala., Fla., N. Car., Md.), **sigma** Coquillett
8. Third antennal joint broadest before middle and slightly tapering to the blunt apex; tibiae largely yellow; front and face of male silvery. (If tergites have paired jet-black spots, see *maculatus*, couplet 66; if notum has a broad intensely black median vitta, see *distinctus*, at 27).......... 9
Third antennal joint in profile broadest at or beyond middle, at least not uniformly tapering from near base.................................10
9. Male: white pilose; proboscis three times head-height; genitalia reddish, the yellow abdominal fasciae narrow; notum with two median black vittae and two broad lateral marks; 3.75 mm. (Baja Cal.)..**albopilosus** Cole
Pile sparse; proboscis not much longer than head-height; abdomen with whitish fasciae, venter white; notum centrally brown continued in front as two median lines; 2.5–4 mm. (Cal.)................**fasciola** Coquillett
10. Males: eyes broadly contiguous along the front.........................11
Females: eyes widely separated.......................................54
11. Thorax and abdomen wholly shining black, at most faintly pruinose below; palpi more than half as long as proboscis; third antennal joint one-half longer than deep; halteres white; 1.6 mm. (Ariz.) (If palpi are small and third antennal joint is longer, see *Apolysis disjuncta*)..........**ater** Cresson
Body more or less opaque, abdomen never polished jet black.............12
12. Front and upper part of face wholly silvery white when viewed from above..13
Front and face more or less golden, brown, blackish, or at most gray pollinose...45
13. Mesonotum uniformly and closely cinereous, of various shades of gray but without dark pattern, at most with extremely faint indications of vittae...14
Mesonotum black or the disk variously marked with dark pattern..........21
14. Head, thorax and abdomen white-pilose, scutellum with retrorse hairs; abdomen cinereous; anterior crossvein at two-fifths to middle of discal cell, basal half of costa yellowish, apical half blackish...................15
Not closely pilose, hairs shorter and more sparse, femora never pilose beneath; abdomen not strongly fasciate; costa not bicolored............17
15. Proboscis four times head-height and strongly curved; body with dense and very long pile; abdomen wholly cinereous; legs wholly black; 3 mm. (Cal.)..**comosus**
Proboscis not over twice the head-height; pile only moderately abundant; knees yellowish...16
16. Abdomen with very narrow yellow incisures; notal hairs on dorsocentral and acrostichal rows, bare between, femora with long hairs beneath; palpi one-third length of proboscis; third antennal joint about twice as long as deep; 2.5 mm. (Cal.)........................**acrostichalis**
Abdomen with strong yellow fasciae; notal hairs uniformly scattered, femora with short hairs beneath; palpi very short; third antennal joint about four times as long as deep; claws and pulvilli large; 6 mm. (Cal.), **retrorsus**
17. Venter mostly yellow, tergites not or but thinly cinereous; anterior crossvein near base of discal cell..18
Venter and dorsum of abdomen similar, black in ground color.............19
18. Tibiae and base of tarsi yellowish; notum and scutellum gray; tergites usually brown, sometimes yellow at base of abdomen, and with paler but not contrasting incisures; second submarginal cell nearly as long as petiole;[2] apical thorn of antennae minute or invisible; proboscis nearly

[2]The petiole is that part of the third vein between the anterior crossvein and the fork.

twice head-height; 1.5 mm. (Cal.) .... **bicolor**
Legs black; notum and scutellum brownish black, tergites black, the incisures contrasting yellow; second submarginal cell distinctly shorter than petiole; antennal thorn distinct; proboscis only slightly longer than head-height; 1.8 mm. (Cal.) .... **dissimilis**

19. Abdominal segments strongly cinereous with narrow yellow incisures, first segment usually more or less yellowish 20
Abdomen wholly black, thinly cinereous, incisures not differentiated; mesonotum with two faint vittae; anterior crossvein at two-fifths the discal cell; 2.75 mm. (Cal.) .... **instabilis**

20. Mesonotum uniformly cinereous; anterior crossvein near middle of discal cell; proboscis less than twice head-height; 1.35 mm. (Cal.) .... **cinereus**
Mesonotum with two faint vittae; anterior crossvein near two-fifths the discal cell; proboscis more than twice head-height; 2.1 mm. (Cal., Ariz.) .... **polius**

21. Tergites with or without cinereous fasciae, but not with distinct yellow bands though the incisures may be very narrowly yellow; legs black, at most the knees narrowly reddish 22
Tergites banded with distinct yellow fasciae on hind margins of segments... 41

22. Mesonotum primarily vittate; abdominal incisures very narrowly grayish or yellowish; palpi and legs black; face bare, cheeks with scattered short hairs 23
Mesonotum not definitely vittate; sides of face usually and the cheeks and occiput white-pilose 27

23. Median dark vitta divided full-length by a cinereous stripe, not reaching scutellum; proboscis not much longer than head, palpi half the length of proboscis; 2–3 mm. (Cal.) (If proboscis is nearly four times head-length, see *longirostris*, couplet 53) .... **divisus**
Median dark vitta divided only in front, usually an attenuated projection to scutellum; proboscis much longer than head-height, palpi relatively shorter 24

24. Inner edge of the cinereous shoulder marks extending beyond transverse suture, each of the two median dark vittae narrower than the enclosed sagittal cinereous spot; abdomen more or less cinereous 25
Disk of mesonotum almost all covered with the blackish pattern, each of the two median dark vittae wider than the enclosed sagittal cinereous triangle; tergites subshining black; veins blackish to base; 1.5 mm. (Cal.) .... **dolorosus**

25. Anterior crossvein near basal third of the relatively small discal cell, sections of fifth vein equal; proboscis less than twice head-height; halteres white. (If proboscis is more than three times head-height, see *longirostris*, couplet 53) 26
Anterior crossvein near basal fourth of discal cell, last section of fifth vein shorter than preceding; proboscis two to three times head-height, thin and straight, palpi about one-fourth as long as proboscis; halteres usually with blackish tip; veins pale at base; 2 mm. (Cal.) .... **pulcher**

26. General color of mesonotum black, the posterior expansions of the cinereous shoulder marks not encroaching on transverse suture; legs wholly black; palpi nearly half as long as proboscis; veins black; 1.5 mm. (Cf. couplet 35.) (Cal.) .... **scapularis**
General color of mesonotum brown, the extensions of the cinereous shoulder marks laterally filling the transverse suture; knees narrowly yellowish; palpi about one-fifth the proboscis; veins pale at base; 1.5 to 2.5 mm. (Cal.) .... **panneus**

27. Mesonotum densely white-pollinose, marked with a wide median opaque black stripe and large double sublateral spots; 3.5 mm. (Cal.) .... **distinctus**
Mesonotum densely cinereous pollinose, marked on each side with two sublateral rounded brown spots; anterior crossvein near base of discal cell; 2.7 mm. (Cal.) .... **neuter**
Disk of mesonotum black or blackish, usually the anterior edge with light-colored pollinose markings 28

28. Proboscis three to four times head-height, very thin, curved, palpi linear, one-sixth as long as proboscis 29

Proboscis shorter, usually thicker, nearly straight, palpi relatively longer; discal cell moderate, last section of fifth vein usually at least half as long as preceding section....30

29. Third antennal joint narrow, not notched; discal cell moderate, sections of fifth vein subequal, anterior crossvein at basal third of discal cell; front and sides of mesonotum coated with cinereous pollen merging into the brownish black disk; 2.4 mm. (See couplet 42.) (Cal.)....**eremitis**

Third antennal joint with preapical notch; discal cell long, sections of fifth vein 3 : 1, anterior crossvein near basal fourth of discal cell; front of mesonotum with three sharply limited whitish triangles, disk opaque black; abdomen not banded; 3 mm. (Cal.) (If notal marks are vague and dark brownish, see *pullatus*, couplet 40)....**sipho**

30. Front part of mesonotum variously marked with white-cinereous pattern...31

Front part of mesonotum with no white-cinereous marks, though sometimes the pollen less intensely black....39

31. Front part of mesonotum with two separated white-cinereous marks, the sagittal area between them black like the disk....32

Front part of mesonotum with white-cinereous pollen on the sagittal portion contiguous or not with the shoulder spots; palpi black....34

32. Palpi yellow except tip; proboscis twice head-height; the two cinereous marks of notum triangular and confluent with the cinereous humeri; abdomen with cinereous fasciae; veins yellowish at base, last section of fifth vein at least half as long as the preceding; second submarginal cell equal to petiole or longer....33

Palpi black; proboscis equal to head-height; the two cinereous marks of notum rounded and separated from the cinereous humeri; veins blackish at base, last section of fifth vein less than half the preceding, second submarginal cell shorter than its petiole; 2.8 mm. (Cal.) (If shoulder marks are triangular, see *scapulatus*, couplet 38)....**bifarius**

33. Third antennal joint widest at middle; knobs of halteres largely black; abdomen fasciate with wide black and narrower cinereous bands; veins firm and blackish; 4 mm. (Cal.)....**lasius**

Third antennal joint widest beyond middle; knobs of halteres yellow; abdomen largely cinereous; veins pale toward base; 3 mm. (Cal.)....**colei**

34. Inner edge of shoulder marks extending to or beyond transverse suture; halteres white; veins more or less blackish at base....35

Cinereous pattern of front edge of notum not nearly reaching transverse suture....36

35. Face bare; markings of thorax rather dull cinereous; 1.5 mm. (Cal.)..**scapularis**

Sides of face bearded almost to antennae; markings of thorax almost silvery white; 2.8 mm. (Cal.)....**loricatus**

36. Abdomen opaque black, at most cinereous on lateral angles; veins black to base; halteres more or less black....37

Abdominal segments broadly cinereous posteriorly; veins yellowish at base; halteres white; notum glaucous; 3 mm. (Cal.)....**togatus**

37. Fare bare; hairs of head, body and legs short; third antennal joint slender, three times as long as deep, broadest beyond middle; 2.2 mm. (Cal.), **bilineatus**

Face bearded; head, thorax and abdomen pilose; third antennal joint wide, twice as long as deep, broadest at middle, with strong thorn....38

38. Third vein forked before end of first vein, costal ratio of marginal and submarginal cells 1 : 1.25 : 1; femora with few hairs; 2.5 mm. (Cal.), **scapulatus**

Third vein forked beyond end of first vein, costal ratio 1 : 2 : 1; femora pilose; 3 mm. (Cal.)....**trifidus**

39. Face strongly bearded; mesonotal suture marked with two cinereous spots on disk, ground color of body steely blue-black; sternites cinereous, margined with yellow; palpi half as long as proboscis; anterior crossvein near middle of discal cell, second submarginal cell longer than petiole; 3.6 mm. (Oreg.)....**chalybeus**

Upper part of face bare; ground color of body black; palpi one-fourth as long as proboscis; second submarginal cell shorter than its petiole; anterior crossvein near basal third of discal cell....40

40. Last section of fifth vein one-third the preceding; mesonotum with front,

sides and large supra-alar spot dark cinereous; sternites cinereous, with yellow incisures; halteres blackish above; 2.3 mm. (Cal.) .... **pullatus**

Sections of fifth vein equal; thorax and body wholly black; halteres white; 1.25 mm. (N. Mex.) .... **cockerelli**

41. Anterior part of mesonotum densely cinereous and narrowly bivittate with brown. (If anterior part is golden cinereous and proboscis is nearly four times head-height, see *longirostris*, couplet 53) 42

Anterior part of mesonotum not bivittate with brown 43

42. Mesonotum cinereous with faint sublateral presutural spot; only knees yellow; palpi one-fourth the length of proboscis, black; 3 to 3.5 mm. (Tex.) .... **bivittatus** Cresson

Disk of mesonotum almost wholly brown behind suture; tibiae and tarsi more or less fuscous; palpi one-eighth the proboscis, yellowish; proboscis three times head-height; 2.4 mm. (See couplet 29.) (Cal.) .... **eremitis**

43. Mesonotum blackish, with faint darker sublateral presutural spot; venter fasciate; pile long on head and abdomen; 3 mm. (N. Mex.) ... **knabi** Cresson

Mesonotum bivittate with cinereous at least in front, the middle brown stripe attenuated anteriorly, the sublateral brown stripes expanded behind suture; venter yellow; nearly bare species. (If mesonotum is almost uniformly dark and face has hairs, see *bicolor*, couplets 18 and 50) ... 44

44. The two cinereous vittae completely separating the distinct middle stripe from the sublateral large brown areas; second submarginal cell enclosing wing-tip; 1.75 mm. (Ariz.) .... **parkeri**

The three vague brown vittae confluent on disk of thorax; anterior branch of third vein ending at wing-tip; 2 mm. (Cf. couplet 49.) (Cal.) **anthonomus**

45. Pile mostly blackish; wings sometimes slightly brownish 46

Pile or sparse hairs white or pale, except sometimes on scutellum; wings hyaline or nearly so 48

46. Mesonotum and abdomen opaque or subopaque black; legs black; sections of fifth vein nearly equal; 1.65 mm 47

Mesonotum densely yellowish-gray pollinose, with a pair of slender vittae and three sublateral black spots; abdomen grayish yellow; legs largely yellow; 5 mm. (Mex.) .... **trochilides** Williston

47. Second submarginal cell shorter than petiole; face bare; second anal vein merely a fold in wing-membrane. (Cal., Oreg., Wash.) .... **palpalis**

Second submarginal cell equal to petiole; face bearing long though sparse hairs; base of second anal vein chitinized. (Cal.) .... **analis**

48. Knees and more or less of tibiae and tarsi yellowish 49

Legs wholly black 51

49. Notum evittate; sections of fifth vein equal 50

Notum vaguely trivittate with brown; last section of fifth vein shorter; proboscis slightly curving down; 2 mm. (Cf. couplet 44.) (Cal.) .. **anthonomus**

50. Proboscis straight; pollen of thorax brown; second submarginal cell opening beyond tip of wing; 1.3 to 2 mm. (N. Mex., Cal.) .... **marginalis** Cresson

Proboscis curving slightly down; pollen of thorax gray; second submarginal cell filling wing-tip; 1.5 mm. (Cal.) .... **bicolor**

51. Mesonotum and abdomen almost wholly black; halteres usually black or blackish; second submarginal cell shorter than petiole; proboscis as long as head-height, palpi two-thirds the proboscis; 2.4 mm. (Cal.) (If proboscis is twice head-height and palpi are one-fifth proboscis, see *pullatus*, couplet 40) .... **lugens**

Mesonotum and abdomen not wholly matte black 52

52. Mesonotum with broad median and sublateral black vittae; abdomen with yellow fasciae; 3 to 3.8 mm. (N. Mex.) .... **mitis** Cresson

Mesonotal markings narrow or weak; yellow abdominal fasciae rather narrow 53

53. Mesonotum broadly trivittate with brown, but the markings faint or even absent; head entirely black; second submarginal cell three times as long as wide; 1.6 to 2 mm. (N. Mex., Tex.) .... **obscurus** Cresson

Mesonotum and scutellum golden brown pollinose, narrowly bivittate in front and with one or two presutural and one postsutural round deep brown spots; front and face pale golden; second submarginal cell four times as long as wide; 2.6 mm. (Cal.) (If scutellum and rear of mesonotum are cinereous pollinose, see *pulcher*, couplet 25) .... **longirostris**

FEMALES

54. Body opaque or subopaque black; legs wholly black, at most knees pale; second submarginal cell ending symmetrically at wing-tip. (Cf. also the dull form of *obscurus* Cresson, couplet 74)........................55
Body variously colored but not uniformly opaque or subopaque black......58
55. Second submarginal cell shorter than petiole, second anal vein only a fold in the wing-membrane..56
Second submarginal cell subequal to petiole, second anal vein chitinized at base; hairs of occiput and thorax black, of face and cheeks pale; 1.65 mm. (Cal.)..**analis**
56. Proboscis less than twice head-height, palpi half as long as proboscis; legs all black..57
Proboscis more than twice head-height, palpi one-sixth as long as proboscis; front oblong and cinereous; knees yellowish; 1.35 mm. (N. Mex.)..**cockerelli**
57. Nearly bare, but all hairs and bristles pale; front a little longer than wide; 2.4 mm. (Cal)...**lugens**
Nearly bare, but hairs and bristles all black; front square; 1.65 mm. (Cal., Oreg., Wash.)...**palpalis**
58. Scutellum, humeri, anterior half of front and first antennal joint yellow; 3 mm..59
Scutellum and at least most of the other parts black in ground color, with more or less dense cinereous coating...............................60
59. Palpi black; ground color of prothorax black; tibiae apically dark; pubescence of upper side golden. (Cal.).......................**togatus**
Palpi yellow at base; prothorax yellow; all tibiae yellow. (N. Mex.), **knabi** Cresson
60. Mesonotum distinctly trivittate with brown or black, i.e., the median dorsocentral dark vittae confluent, not divided by a middle line of lighter colored pollen, the sublateral vittae more or less interrupted at suture..61
Mesonotum otherwise marked or evittate, but not with an undivided median dark vitta...65
61. Palpi black, about one-third or one-fourth head-height; legs all black; venter more or less fuscous; ground color of head black.................62
Palpi very short; at least knees yellowish............................63
62. Tergites opaque black with white fasciae; thoracic vittae separated by more or less distinct cinereous interspaces except in front, the supra-alar spot somewhat isolated; proboscis about three times head-height; 2 mm. (Cal.) (If vittae and fasciae are very weak, see *obscurus*, couplet 74)..**pulcher**
Tergites subshining black, with yellow fasciae; thoracic vittae vaguely separated, confluent with the supra-alar spot; proboscis about twice head-height; 1.5 mm. (Cal.).................................**dolorosus**
63. Wholly white-pollinose except for the contrasting opaque black color pattern; face and occiput white-pilose; 3.5 mm. (Cal.)...........**distinctus**
Light-colored pollen cinereous, the dark pattern brown; venter yellow; nearly bare species..64
64. Middle stripe of thorax broad; front and face with a broad black median stripe, orbits yellow; palpi yellow; legs largely yellow; 2 mm. (N. Mex.), **formosus** Cresson
Middle stripe of thorax narrow, almost pointed in front; orbits not differentiated; palpi black; only knees yellow; 2.5 mm. (Ariz.)..........**parkeri**
65. The black and blackish bases of abdominal segments when viewed from behind more or less broadly interrupted medially......................66
If the bases of the abdominal segments are blackish the bands are complete..67
66. Thorax with five large jet black spots; abdominal marks black; proboscis over three times head-height, curved, palpi black; face cinereous, closely pilose; third antennal joint four times as long as deep; tibiae mostly yellow; branch of third vein arising abruptly; 4.2 mm. (Cal.)...**maculatus**
Thorax with four dark brown vittae, the interspaces cinereous; abdominal marks blackish; proboscis twice the head-height, palpi yellow except tip; face yellow, bare; third antennal joint rounded, less than three times as

long as deep; only knees yellowish; branch of third vein gently curving; 3 mm. (Cal.) (If posterior half of front and spaces between vittae are brown, see *lasius*, couplet 86; if thorax is evittate, see *eremitis*, couplet 76) .... **colei**

67. Legs including knees wholly black, sometimes the knees minutely reddish ... 68
Front tibiae more or less yellow, or at least knees distinctly yellowish 85

68. Thoracic vittae almost or wholly wanting 69
Thorax bivittate in front and with three or four sublateral dark spots; abdomen more or less fasciate 75

69. Very pilose; anterior crossvein at middle of discal cell; front about twice as broad at antennae as at ocelli; white-cinereous species, basal half of costa yellow, distal half blackish; 3 to 6 mm. (Cal.) .... **comosus**
Nearly bare species; sides of front nearly parallel (*obscurus* unknown) 70

70. Thorax deep brown, with two prominent cinereous shoulder triangles; abdomen black, the incisures narrowly yellow; 2.5 mm. (Cal.) .... **scapulatus**
Thorax cinereous or weakly vittate, but not with shoulder triangles 71

71. Anterior crossvein at basal third or middle of discal cell, the first basal cell longer than the second; abdomen more or less fasciate 72
Anterior crossvein near base of discal cell, the two basal cells nearly coextensive; abdominal fasciae almost wanting 74

72. Abdomen largely or almost wholly yellow, venter all yellow; the cinereous coating of head and thorax with slight golden tone; first basal cell distinctly longer than second, the sections of fifth vein equal; 1.35 mm. (Cal.) .... **cinereus**
Abdomen mostly black, fasciae narrow, venter like dorsum; the cinereous coating of head and thorax whitish gray 73

73. Anterior crossvein near middle of discal cell, the first basal cell distinctly longer than second, sections of fifth vein subequal; 2.5 mm. (Cal.) .. **panneus**
Anterior crossvein nearer base of discal cell, the first basal cell longer than second by length of crossvein, last section of fifth vein shorter than preceding; 2.1 mm. (Cal., Ariz.) .... **polius**

74. The weak thoracic markings consisting of a broad median and two narrow stripes, or absent; head entirely black; 1.6 to 2 mm. (N. Mex., Tex.), **obscurus** Cresson
The thoracic pattern consisting of a divided brown median stripe and vague sublateral marks; front anteriorly cinereous, posteriorly brown, face cinereous, upper occiput brown; 2 to 3 mm. (Cal.) .... **divisus**

75. Facial orbits closely hairy, front cinereous and pubescent; third antennal joint nearly three times as long as deep; palpi half as long as proboscis; abdominal fasciae cinereous; 3 to 3.8 mm. (N. Mex.) .... **mitis** Cresson
Face nearly or completely bare, front more or less brownish and nearly bare; third antennal joint shorter; abdomen without complete cinereous fasciae 76

76. Third antennal joint slender, three times as long as deep, not notched; proboscis more than three times head-height, slender, palpi one-sixth the proboscis; sides of thorax cinereous; 2.4 mm. (Cal.) .... **eremitis**
Third antennal joint shorter, with preapical notch 77

77. Proboscis about four times head-height, palpi about one-sixth the proboscis; pollen of head and of thorax between the dark vittae golden brown 78
Proboscis shorter, palpi relatively longer, usually about half the length of the proboscis; pollen at least of side margins of thorax cinereous 80

78. Discal cell elongate, sections of fifth vein 3 : 1 to 2 : 1 79
Discal cell normal, sections of fifth vein about 4 : 3; abdominal fasciae distinct, sides of abdomen black; 2.6 mm. (Cal.) (If thorax has a sagittal intervittal brown line, see *montanus*, couplet 6) .... **longirostris**

79. Sublateral vitta entire; second vein ending much nearer first than to branch of third vein; 3 mm. (Cal.) .... **sipho**
Sublateral vitta interrupted at transverse suture; second vein ending midway between first and branch of third; 2.3 mm. (Cal.) .... **pullatus**

80. Occiput and mesonotum frosted cinereous, vittae narrow and pale brown, a sagittal vitta projecting from scutellum between the normal middle pair; front frosted cinereous with a light brown spot before ocelli;

abdomen pubescent; third antennal joint less than twice as long as deep, deeply notched; 2.7 mm. (Cal.) .... **neuter**
The pair of median vittae blackish or brown, no dark extra stripe on sagittal line between the vittae; nearly bare species; front largely or wholly brownish-pollinose; third antennal joint 2 to 2.5 times as long as deep 81

81. General color of abdomen deep black, without cinereous pollen, the incisures narrowly pale yellow; the two median black vittae linear; third antennal joint scarcely excised; proboscis short; 2.2 mm. (Cal.) ... **bilineatus**
General color of abdomen usually largely cinereous, at least on sides, the fasciae rarely contrasting; vittae not linear 82

82. Discal cell rather small, sections of fifth vein nearly equal, last section of fourth vein longer than preceding; general color of notal disk between vittae brownish cinereous; 1.5 mm .... **scapularis**
Discal cell longer, the sections of fifth vein 2 : 1, last section of fourth vein not longer than preceding; general color of notal disk dark brown.... 83

83. Notal vittae and spots diffuse 84
Notal vittae and spots strong; 3 mm. (Cal.) .... **trifidus**

84. Abdominal fasciae bright yellow, nearly one-fourth the segments; 2.8 mm. (Cal.) .... **loricatus**
Abdominal fasciae sordid yellow, narrow; 2.8 mm. (Cal.) .... **bifarius**

85. Thorax with two narrow dark median vittae in front and more or less distinct sublateral spots 86
Thoracic markings faint or wanting 87

86. Palpi black; notum largely cinereous, the lateral spots weak; abdominal fasciae yellow; 3.5 mm. (Tex.) .... **bivittatus** Cresson
Palpi yellow except tip; mesonotum largely brown pollinose, the lateral spots strong; abdominal fasciae cinereous; 5 mm. (Cal.) (If vittae are bounded by cinereous pollen, see *Colei*, couplet 66) .... **lasius**

87. Legs wholly or largely yellowish 88
Only knees yellow; pollen of body dense, golden-gray or cinereous 92

88. Abdomen wholly yellow; proboscis slightly curving down 89
Abdominal tergites black or blackish at base, fasciate with yellow 90

89. Proboscis less than twice head-height; head and thorax brownish; femora dusky near middle; 1.8 mm. (Cal.) .... **dissimilis**
Proboscis more than twice head-height; head and thorax grayish; legs light yellow; 1.5 mm. (Cal.) .... **bicolor**

90. Proboscis three times head-height, slightly curving down, palpi yellow; femora black except knees; third antennal joint slender, three times as long as deep, not notched; petiole of anal cell longer than anterior crossvein; 2.4 mm. (Cal.) (If palpi are black and petiole of anal cell is shorter than crossvein, see *retrorsus*, couplet 93; if incisures are narrowly white, see *polius*, couplet 92) .... **eremitus**
Proboscis twice head-height or shorter, nearly straight; third antennal joint shorter 91

91. Femora mostly black; anterior crossvein near middle of discal cell, petiole of anal cell shorter than anterior crossvein; disk of scutellum with some retrorse pile; 2.4 mm. (Cal.) .... **acrostichalis**
Femora mostly yellow; anterior crossvein near base of discal cell, petiole of anal cell longer than crossvein; disk of scutellum bare; 2 mm. (Cal., N. Mex.) .... **marginalis** Cresson

92. Anterior crossvein near middle of discal cell 93
Anterior crossvein near base of discal cell; body black but heavily cinereous pollinose, abdominal segments narrowly white behind; 2.1 mm. (Cal., Ariz.) .... **polius**

93. First antennal joint yellowish; discal cell large, last section of fifth vein only a little longer than posterior crossvein; palpi about one-eighth length of proboscis; yellow fasciae of abdomen wide; 5 mm. (Cal.) (If no yellow fasciae, see *Colei*, couplet 66) .... **retrorsus**
Antennae black; discal cell moderate, the last section of fifth vein nearly twice length of posterior crossvein; palpi one-fourth as long as proboscis; 2.5 mm. (Cal.) .... **acrostichalis** var. **matutinus**

Oligodranes acrostichalis, n. sp.

Male.—Length 2.4 mm. Whitish cinereous, heavily pollinose, with abundant long white pile. Ocellar triangle cinereous, frontal triangle nearly equilateral, extending halfway to ocellus, satiny white, face wider than combined length of basal antennal joints, above with satiny white triangle which appears dark when seen from front, sides loosely pilose almost to antennae, mouth-opening blackish, antennae black, cinereous, second joint globular, first joint shorter, third joint bluntly elliptical, widest at middle, scarcely notched above tip where there is a minute stubby black style; proboscis 1.5 times head-height, nearly straight, palpi black, slender but thickest at two-thirds. Thorax and abdomen wholly cinereous, scutellum with retrorse pile; abdominal incisures narrowly whitish. Legs black except knees, moderately cinereous, femora pilose beneath. Wings hyaline, veins yellowish, costa black beyond first vein, second submarginal cell about 3.5 times as long as wide, second vein ending before middle of second submarginal cell, sections of third vein 4 : 5, anterior branch ending at wing-tip, sections of fourth vein 2 : 3 : 5, of fifth vein 3 : 2, petiole of anal cell as long as anterior crossvein, ambient vein complete; halteres white.

Female.—Pile short. Thorax cinereous pollinose with slightly yellowish tinge. Front slightly narrowed posteriorly, nearly as wide at antennae as its length; occipital weals low-placed and strong, post-vertical grooves weak; proboscis thicker and quite straight, palpi longer. Basal two-thirds of tibiae and base of metatarsi yellowish. Ground color of abdomen almost wholly yellowish white, tergites 2 to 7 black at base though sides broadly yellow. Anterior crossvein at middle of discal cell.

Types.—Three males and four females collected at Palm Springs, California, 24 April, 1944, during the morning only, on flowers of Malacothrix.

Oligodranes acrostichalis, var. **matutinus,** n. var.

A female taken with the others is different from all the other species and is distinct enough to receive at least a varietal name. It is close to ***acrostichalis***, but has shorter and sparser hairs, front more brownish, proboscis thicker and slightly curved down, the palpi one-fourth the length of the proboscis, the basal two-thirds of abdominal tergites blackish beneath the cinereous pollen, venter with basal half of segments similarly dark; legs wholly black except the narrow knees; anal cell closed at margin, anterior crossvein just before middle of discal cell.

Holotype.—Palm Springs, California, 24 April, 1944. A female in the Citrus Experiment Station, taken by P. H. Timberlake at San Lucas, California, 20 August, 1935, on ***Eriogonum gracile***, has the yellow color more extended on knees and venter. ***Matutinus***, Latin, active during the morning hours, referring to its fondness for ***Malacothrix***, the flowers of which close in the afternoon.

Oligodranes analis, n. sp.

Male.—Length 1.65 mm. A sombre opaque black, black-pilose

species with black legs, blackish halteres and slightly infumated wings. Front hairy, face with long hairs to antennae; first joint of antennae slightly longer than second, hairy above, third joint oval, twice as long as deep, widest at middle, apically rounded, excavated above tip with stubby erect thorn; proboscis but little longer than head-height, straight, palpi nearly half as long as proboscis, thin. Disk of scutellum bare, margin with eight or ten strong hairs. Veins black to base, costal cell opaque; sections of third vein 1.2 : 1, the anterior branch ending at wing-tip, sections of fourth vein 1 : 4 : 5, fifth vein 4 : 3, anal petiole twice the length of anterior crossvein, ambient vein weak beyond anal vein; halteres yellowish to fuscous or even black, calypteres black.

Female.—Pollen of head and thorax with dark brown tinge; hairs shorter and sparse, those of face and cheeks pale; sides of front nearly parallel, occipital weals and grooves undeveloped; submarginal cell a little longer; knob of halteres yellow.

Holotype.—Near Hemet Lake, on the Southern base of Mount San Jacinto, California, 7 June, 1942; *allotype:* Ortega Highway, three miles due Southwest of Lake Elsinore, California, elevation 2600 ft., 26 May, 1944. *Paratypes:* Sixteen males and twenty-six females, all from Southern California, with types; from Oak Grove, 8 May, 1945; Sheep Creek Canyon near Phelan, 24 May, 1945; Cajon, 28 June, 1945; Mountain Home, 21 June, 1945; Barton Flats in San Bernardino Mountains, 16 June, 1945, on *Ceanothus.* A female from The Gavilan, Riverside County, 13 June, 1938, was taken by P. H. Timberlake on *Adenostemon fasciculatum.*

This is the only species having the second anal vein chitinized, which however becomes evanescent at about three-fourths its length. One of the females lacks the posterior crossvein of the left wing, a condition suggestive of the origin of *Apolysis* and *Empidideicus* from forms with complete neuration.

Oligodranes anthonomus, n. sp.

Male.—Length 2 mm. Face bare, occiput cinereous, hairs sparse, weals distinct, extending above neck; third antennal joint 2.75 times as long as deep, nearly oblong, obliquely truncate above tip and with thorn and setula; proboscis twice the head-height, slightly curving downward, palpi fuscous, thin, one-sixth the length of proboscis. Thoracic pattern not contrasting, front third of notum cinereous merging into the dark brown disk but leaving three brown linear vittae, posterior area and scutellum brownish cinereous and not vittate, lateral margin when viewed from side continuously cinereous, pleura cinereous. Abdomen black except first segment yellow, next three with yellowish white margins, segments 5 to 7 with narrow yellowish incisures, venter yellowish, lateral hairs white, radiating, the dorsal hairs shorter and reflexed. Legs black, knees yellowish. Wings clear hyaline, veins thin, fuscous, paler at base, first basal cell longer than second, sections of fourth vein 1 : 3 : 4, of fifth vein about 2 : 1, anal petiole longer than anterior crossvein; halteres whitish.

Female.—Front 1.7 times as long as width at ocellus, wider at antennae, brownish posteriorly merging to cinereous in front, center of

face obliterated by mouth; occipital weals distinct. Cinereous pollen of front half of mesonotum with yellowish tone, the darker vittae indistinct. Abdominal incisures, lateral margin and venter yellow. Apices of coxae, trochanters, base and apex of femora, anterior tibiae, base of anterior metatarsi and hind knees yellowish. Anterior crossvein at basal fourth of discal cell.

Holotype and allotype: About six miles Southwest of Adelanto, California, in the Mojave Desert, 23 May, 1945. The species name is from the Greek and means feeding on flowers.

Oligodranes bicolor, n. sp.

Male.—Length 1.5 mm. Nearly bare, occiput and thorax dark cinereous, humeri and posterior calli with yellow dot, a few marginal hairs on scutellum, abdomen fuscous, the first segment and incisures yellow, venter yellow except apex. Sides of face and cheeks as wide as a basal joint of antenna, with scattered short hairs almost to antennae; eyes contiguous three-fourths the distance between ocellus and antennae; proboscis scarcely twice as long as head-height, palpi very thin, one-fifth the length of the proboscis, dull yellowish; basal joints of antennae spherical, third joint oval, widest at middle, scarcely twice as long as deep, with an extremely minute point above apex. Legs blackish, knees, tibiae and base of tarsi yellowish. Wings hyaline, veins thin, dark except at base, last two sections of third vein subequal, second submarginal cell three times as long as wide, the anterior branch ending at wing-tip, sections of fourth vein 1 : 3 : 4, of fifth vein 4 : 3, anal petiole longer than anterior crossvein, ambient vein evanescent along posterior border; halteres whitish.

Female.—Head and thorax brownish cinereous, abdomen and legs including apex of coxae light yellowish, ends of tarsi darker. Sides of front nearly parallel, the width four-fifths the length; occipital weals moderate, postvertical grooves not developed.

Types collected from flowers, base of Piute Butte, in Western Mojave Desert, California, 12 May, 1944. Thirty-six male and seven female *paratopotypes*; six males and four females, Quail Springs and vicinity, 5 October, 1934, two females, Morongo, 28 September, 1944; one female, near Whitewater, 27 October, 1934, all in Southern California. The autumnal specimens, which are all from near the Little San Bernardino Mountains, differ from those from the Mojave Desert only in having the humeri somewhat more yellow and the abdomen of the male lighter in color.

In the Citrus Experiment Station there are four specimens collected by Professor Timberlake: a male from Mission Canyon, 1 October, 1932, on *Lepidospartum*, a male from Palm Springs, 28 March, 1936, on creosote bush; a female from Victorville, 28 October, 1934, on rabbit-brush, *Chrysothamnus*, a female from Whitewater, 27 October, 1934, on *Aplopappus acradenius*. Apparently the species is double-brooded.

Oligodranes bifarius, n. sp.

Male.—Length 2.8 mm. Closely related to *O. trifidus*, differing from its diagnosis thus: Proboscis usually shorter, oblique. White cinereous

pattern of thorax consisting only of two rounded spots on anterior edge separated from the cinereous humeri, the sides dull cinereous, the black forward extension of disk about as broad as the light colored spots. Lower part of pygidium with a finger-like extension near middle of inner edge. Alulae wholly white except the extreme black base.

Female.—The dark thoracic markings brown, not sharply differentiated. Rim of alulae white; knob of halteres white.

Types: Four males and six females, Sheep Creek Canyon, near Phelan, California, 24 May, 1945.

Two females in Citrus Experiment Station, collected by P. H. Timberlake: The Gavilan, Riverside County, 1 April, 1938, on *Plagiobothrys californicus*, and Big Bear Valley, California, 6 July, 1934, on *Apocynum androsaemifolium*. *Bifarius*, Lat., divided into two parts, referring to the double marks on front of thorax.

Oligodranes bilineatus, n. sp.

Male.—Length 2.2 mm. Sombre, opaque black, thinly pilose, the hairs all pale. Front and face satiny white, face bare; cheeks and occiput thinly cinereous, beard sparse and short; basal joints of antennae equal, third joint elongate pyriform, 2.5 times as long as deep, widest at three-fourths, the preapical notch and thorn minute; proboscis only slightly longer than head-height, palpi two-thirds the length of the proboscis, black, slender. Mesonotum with semicircular white-cinereous collar, which when viewed from above is divided into three parts by two black extensions of the disk, sides very lightly dark cinereous, encroaching along the suture, pleura dark cinereous, disk of scutellum bare, margin fringed with twenty hairs. Venter of abdomen somewhat cinereous, incisures yellowish. Legs all black, the femora not cinereous. Wings very slightly infumated, veins black to base, second submarginal cell encompassing tip of wing, three times as long as wide, sections of third vein 5 : 4, of fourth vein 1 : 3 : 4, of fifth vein 3 : 2, anal petiole longer than anterior crossvein, ambient vein complete but thin; halteres infuscated.

Female.—Head and thorax dull brownish black, slightly gray on lower occiput, behind humeri, on pleura and venter. Front parallel-sided, slightly longer than wide; occiput without weals or grooves. Notum marked with two well separated somewhat subshining black lines which reach from prothorax to midway between suture and scutellum, and with a sublateral vitta interrupted at suture, abbreviated in front but longer behind, the supra-alar spot weak. Abdomen pure black above, the margins of segments narrowly yellow.

Holotype and allotype: Big Bear Lake, San Bernardino County, California, 6 July, 1941. *Paratypes:* Another pair collected with the types, a male from Pinehurst, 7 June, 1935, two females from Oak Grove on the Northeast base of Mount Palomar, 8 May, 1945, and three females from Sheep Creek Canyon, San Bernardino County, 24 May, 1945, all in California.

Oligodranes chalybeus, n. sp.

Male.—Length 3.6 mm. Upper occiput black, lower cinereous and

with white beard, mouth-opening black, silvery part of face nearly horizontal and tapering into the orbits, lower face and cheeks white-cinereous with long white pile to the silvery section; eyes contiguous three-fourths the distance to antennae; antennae black, first joint a little longer than the globular second, third joint nearly twice as long as the basals together, widest at middle, slightly over twice as long as deep, blunt, with flattened emargination above tip bearing a minute stubby thorn; proboscis 1.5 times the head-height, nearly straight, palpi black, thin, half as long as proboscis. Mesonotum opaque black, in front with very faint indications of two abbreviated narrow brownish vittae, white pilose, especially behind humeri, mesopleura with long straggling hairs, pleura rather thinly cinereous. Scutellum and abdomen opaque black above, the last two segments, apical angles of tergites and venter cinereous. Legs wholly black, thinly cinereous, femoral hairs long. Wings hyaline, veins fuscous, paler at base, second submarginal cell proximally narrow, about four times as long as wide, sections of third vein proportioned 3 : 4, the anterior branch ending at wing-tip, fourth vein 5 : 6 : 10, fifth vein 3 : 2, anal petiole shorter than anterior cross-vein, ambient vein complete.

Holotype: Mount Hood, Oregon, at 3,000 feet, 29 July, 1921.

Oligodranes cinctura Coquillett and variety **setosa** Cresson

Figure 10

This species represents an extreme form of *Oligodranes*. Coquillett's original species has the thorax of the female trivittate with loose gray pollen and the beard of the male black. I have a pair from Magnesium Springs Canyon, near Cathedral City, California, in which the female agrees but the male has all the hairs of the head pure white excepting a few individual hairs on the lower occiput.

Cresson described *setosa* from a form with shining thorax in both sexes, black beard in male, and widely open second submarginal cell. I have a pair from Yakima, Washington, in which the male agrees but the female has the second submarginal cell narrow as usual.

The third antennal joint varies in length from two to three times as long as deep. Some females have the occipital weals excessively developed into outstanding welts. I have taken the ***cinctura*** form with pollinose thorax from Western Mojave Desert and Cathedral Canyon, California, and the ***setosa*** form with shining thorax from Pullman, Washington; Worley, Idaho; and Barton Flats in the San Bernardino Mountains, California. Professor Timberlake has collected ***cinctura*** on Mountain Home Creek in the San Bernardino Mountains on ***Gilia***, and ***setosa*** on Herkey Creek in the San Jacinto Mountains, California, on ***Gilia exilis***.

Oligodranes cinereus, n. sp.

Male.—Length 1.35 mm. Sparsely short-pilose. Frontal triangle and facial orbits satiny white, face with about five hairs, cheeks and occiput uniformly cinereous, postocellar grooves confluent just behind the ocellar triangle, weals reaching halfway along the occiput, mouth-opening black; eyes contiguous halfway to antennae; antennae black,

thinly cinereous, basal joints equal, third joint elliptical, slightly over twice as long as deep, excised above apex, with small thorn; proboscis less than twice head-height, nearly straight, palpi one-sixth as long as proboscis. Thorax uniformly cinereous, with no indications of vittae, scutellar disk with very few erect hairs. Abdomen definitely cinereous, not shining, incisures narrowly whitish, first segment usually more or less yellowish. Knees very narrowly slightly reddish. Wings hyaline, costal cell opalescent, veins mostly pale, first vein reaching apical third of costa, second vein curving forward at end, costal ratio between first and third veins 1 : 1 : 0.5, segments of fourth vein 1 : 1 : 3, of fifth vein subequal, anal petiole as long as anterior crossvein, ambient vein complete.

Holotype: Base of Piute Butte in Western Mojave Desert, California, 12 May, 1944. *Paratypes:* Three topotypic males, 24 April, 1946; one male, Palm Springs, California, 24 April, 1944; and two males, six miles East of Garnet, California, 4 April, 1945. A female from Verdemont, California, 23 April, 1946, has been included in the key as possibly this species.

This seems to be a reduced form of *acrostichalis*, distinguished from the other small species by the uniformly pure cinereous thorax.

Oligodranes cockerelli, n. sp.

Male.—Length 1.25 mm. Body including abdomen wholly black, nearly bare, the few hairs short and white. Proboscis 1.75 times the head-height, thick, palpi one-fourth as long as proboscis. Legs black, knees narrowly yellowish. Wings clear hyaline, veins blackish to base, basal cells of same length, second submarginal cell three-fourths as long as its petiole, the anterior branch of third vein ending just before wing-tip, sections of fourth vein proportioned 1 : 2.75 : 4, anal petiole slightly longer than anterior crossvein; knob of halteres white.

Female.—Proboscis thick, curving down, palpi thin and fuscous; the yellow of front knees more extended than in male.

Types.—A pair received from Professor T. D. A. Cockerell, who collected them on flowers of a *Fallugia*, seven miles East of Grants, New Mexico, 23 May, 1945.

I have the honor to dedicate this species to Professor Cockerell, who sent the specimens as being the smallest flies he had ever seen.

Oligodranes colei, n. sp.

Male.—Length 3 mm. Front and facial orbits glistening white, the front and first antennal joint above with a few short hairs, sides of face pilose quite to the antennae, wider than basal antennal joint, occiput cinereous, pilose, beard prominent, oral opening mostly black; antennae black, cinereous, basal joints equal, third joint but little longer than basal pair, elongate pyriform, about twice as long as deep, flattened but not excised above apex, the thorn and setule invisible; proboscis nearly twice head-height, nearly straight, palpi one-third as long as proboscis, slender, preapically spatulate, yellow, the tip blackish. Mesonotum loosely pilose, mostly opaque black, the two shoulder triangles white-cinereous, sides blending into cinereous, which extends

in along the transverse suture, pleura white-cinereous, mesopleura pilose, scutellum opaque black, nearly bare, the margin thinly cinereous with long pile. Abdomen pilose, black in ground color, the first segment and margins of the others cinereous, venter cinereous with hind margins yellow. Legs black, knees very narrowly reddish, pile long on coxae and underside of femora. Wings hyaline, veins thin, dark, yellowish at base, second submarginal cell as long as its pedicel, narrow at base, the anterior branch of third vein ending at wing-tip, sections of fifth vein 3 : 2, anterior crossvein at or near middle of discal cell, anal petiole shorter than anterior crossvein; ambient vein complete; halteres white.

Female.—Face, cheeks and anterior margin of front yellow, remainder of head strongly cinereous; basal antennal joints fuscous; front nearly square; moderate occipital weals on each side of neck, postvertical grooves very shallow. Mesonotum largely cinereous, quadrivittate with brown, the median vittae narrow, stopping much before the cinereous scutellum, the sublateral vittae broader, coextensive behind but shortened before suture, a small supra-alar spot, posterior hairs retrorse; pleura light cinereous, meso- and sternopleura hairy. Abdomen loosely hairy, largely cinereous, the bases of the second and following segments blackish, more or less interrupted medianly by the posterior cinereous borders (best seen from behind), ventral segments with yellow incisures, last segment yellow. Femora pubescent.

Holotype: Morongo, California, 28 September, 1944. *Allotype:* Quail Spring in the Joshua Tree National Monument, California, 5 October, 1934. *Paratypes:* One male and four females taken with the allotype.

The species is named in regard for my friend and colleague, Doctor Frank R. Cole, who was on the trip to Quail Springs when the specimens were taken.

Oligodranes comosus, n. sp.

Figure 3

Male.—Length 4.5 mm. Wholly and densely white-cinereous pollinose and abundantly clothed with long white pile. Front much wider than high, snowy white, sides of face wide and heavily bearded; basal joints of antennae cinereous, first joint twice as long as second, third joint elongate elliptical, 3.5 times as long as deep, the preapical notch and thorn small; proboscis strongly curved, five times head-height, palpi one-tenth as long as proboscis. Pro-, meso- and front half of sternopleura heavily pilose, scutellum with dense erect pile. The abundant hairs of abdomen twice as long as segments. Legs black, the yellow pulvilli long, claws yellow at base and about as long as last tarsal joint, femora pubescent, closely pilose below. Wings hyaline, veins blackish, basal half of costa and the two veins behind yellowish, veins pale at base, a patch of white hairs on base of costa, first basal cell longer than second by three times anterior crossvein, costal ratio between first and third veins 1.25 : 1 : 0.75, third vein forked before end of first vein, the branch arising in a gentle curve and ending at wing-tip, sections of fourth vein 1 : 0.9 : 1.25, of fifth vein 1.8 : 1, posterior crossvein slightly arcuate or sinuous, anal petiole as long as anterior crossvein, ambient vein complete; halteres yellowish, alulae white.

Female.—Length 3 to 6 mm. Densely pilose; occipital weals long, strong and nearly straight; front almost white, pubescent, as wide at antennae as long, tapering to half-width at ocelli; abdominal segments margined with yellow.

Type and allotype: About five miles East of Palm Springs, California, 17 April, 1937, collected by P. H. Timberlake on Indigobush, *Dalea Schottii* (Citrus Experiment Station collection). *Paratypes:* A male, Box Canyon, California, 4 April, 1937, on Desert poppy, *Eschscholtzia minutiflora* (Timberlake); a female, Palm Canyon of the Borego Desert, California, 29 March, 1936, on Creosotebush, *Larrea divaricata* (Timberlake); a female, Deep Creek, California, 16 May, 1927, on Deerweed, *Lotus scoparius* (Timberlake, CES); one male, three miles West of Palm Springs, California, 6 May, 1946, on Indigobush. *Comosus*, Latin, having abundant, long hair.

Oligodranes dissimilis, n. sp.

Male.—Length 1.8 mm. Nearly bare, head, thorax, upper side of abdomen and legs blackish in ground color, the upper occiput and thorax overlaid with fine dark brown pollen, becoming dull gray at neck and on lower occiput; abdomen opaque, the incisures narrowly but contrastingly yellow, first segment piceous, base of sternites slightly darkened. Frontal triangle silvery, wider than high, lower face and cheeks with a few straggling short hairs, sides of face as wide as basal antennal joint; eyes contiguous two-thirds the way to the antennae; basal joints of antennae equal, spherical, third joint slightly widest at middle, 2.5 times as long as deep, blunt, the preapical excavation distinct and bearing a sharp thorn and above it an evident though minute setule; proboscis 1.2 times the head-height, curving slightly, palpi one-third as long as proboscis, thin, fuscous. Wings hyaline, second vein ending beyond middle of second submarginal cell, sections of third vein proportioned 17 : 13, the anterior branch ending just before wing-tip, sections of fourth vein 1 : 4 : 5, of fifth vein 11 : 9, anal petiole as long as anterior crossvein; halteres yellowish white.

Female.—Pollen of head and thorax light brown and denser and almost cinereous on pleura and lower occiput; abdomen wholly yellow, but the sixth and seventh tergites darkened except sides and incisures (possibly individual discoloration); coxae apically, trochanters, ends of femora, tibiae except distal part of hind pair, yellow; sides of front nearly parallel, width of front at antennae four-fifths the length; occipital weals rather well developed, postvertical grooves very weak.

Types: Two specimens, Morongo, S. W. San Bernardino County, California, 26 September, 1944. Closely allied to *O. bicolor*. The male and female show great dimorphism.

Oligodranes distinctus, n. sp.

Male.—Length 3.5 mm. Heavily coated with white pollen except a V-shaped postocellar groove, the intense opaque black thoracic decorations, a triangular scutellar spot, a black band on base of second tergite and three small basal spots on third tergite. Pile long and white, dense on face, loose on notum and abdomen. Front much broader than

high, intensely white pruinose; occipital weals narrow, extending halfway up; basal joints of antennae equal, cinereous, third joint black, three times as long as deep, widest just before middle, blunt, scarcely excised, with microscopic terminal point and preapical setule; proboscis 2.5 times head-height, rigid, slightly curved, palpi one-twelfth as long as proboscis. Median stripe of notum wide, not reaching neck or scutellum, notched behind, presutural spot large and oval, narrowly separated at suture from the large U-shaped posterior mark; pleura heavily white-pollinose, mesopleura densely pilose; scutellar hairs long, sparse, erect. Incisures of tergites and sternites narrowly whitish but scarcely differentiated beneath the dense whitish coating; pygidium triangular, with two appressed ovoid cinereous large dorsal valves. Legs black, hairs of the cinereous femora equal to their diameter, knees very narrowly fuscous. Wings hyaline, veins dark apically and yellowish basally, third vein ratio 5 : 4, branched much before end of first vein, the fork widely curving and ending just before wing-tip, fourth vein 1 : 3 : 2.5, fifth vein 3 : 2, the last section as long as posterior crossvein, anal petiole equal to anterior crossvein, ambient vein abruptly stopping at anal vein; halteres and alulae white.

Female.—Pile shorter but equally dense; occipital weals extending two-thirds; palpi one-eighth the proboscis length; sublateral thoracic vitta smaller, the posterior section broken into two oval spots; tip of abdomen compressed, yellow.

Holotype and allotype: Verdemont, near San Bernardino, California, 1 May, 1946. *Paratypes:* A female taken with the types; one female from Southern base of Piute Butte in Western Mojave Desert, California, 12 May, 1944.

The species is easily recognized by its contrasting colors and the black color pattern of the thorax.

Oligodranes divisus, n. sp.

Male.—Length 2 mm. Cinereous, thorax quadrivittate, abdomen opaque blackish above, dark cinereous beneath. Front and upper face satiny white, remainder of face narrowly white pollinose, cheeks and occiput cinereous, postocellar grooves deep, no weals; eyes contiguous two-thirds the distance to antennae, ocellar triangle black; basal joints of antennae equal, third joint elliptical, widest at middle, 2.5 times as long as deep, preapical notch minute, thorn and setule microscopic. Thoracic vittae brownish black, the two middle vittae beginning just behind pronotum, narrow at first, stopping midway between suture and scutellum, the side vittae interrupted just behind suture, the anterior spot elliptical, the posterior tapering behind and evanescent just before scutellum, supra-alar spot rather small; broad front of the side margins, most of the posterior part, scutellum and pleura cinereous, mesopleura with a faint brown spot. Sternites with whitish margins, narrow on caudal segments. Legs not cinereous. Wings hyaline, veins thin, blackish, becoming fuscous at base, sections of third vein 5 : 4, of fourth vein 1 : 3 : 4, of fifth vein 5 : 4, anal petiole shorter than anterior crossvein, ambient vein evanescent on anal lobe; halteres white.

Female.—Thoracic pattern greatly weakened; front behind the

transverse depression, vertex and scutellum brownish; tergites cinereous on sides, more so on caudal segments. Front one-fourth longer than wide, parallel-sided; occipital vertical weals strong, postocellar V-grooves distinct.

Holotype and allotype: Magnesium Springs Canyon, midway between Palm Springs and Indio, California, 5 April, 1945.

A male measuring three millimeters, from Palm Springs, 24 April, 1944, differs in having the tergites laterally cinereous, with posterior margins noticeably yellow, and the discal cell somewhat longer. A female from the desert near Adelanto, California, 23 May, 1945, appears to belong to *divisus*, though its general color is more gray and the anterior crossvein is nearer the middle of the discal cell.

Oligodranes dolorosus, n. sp.

Male.—Length 1.5 to 2 mm. Hairs sparse and pale. Ocellar triangle black, front and upper face white pruinose, lower face white pollinose, upper occiput dark brown, lower part dark gray; basal joints of antennae equal, third joint obovate, twice as long as deep, the notch small, thorn minute. Mesonotum mostly occupied by the blackish brown pattern, leaving only the humeri, posthumeral triangles, a V-shaped notch at front of median vitta, sides and four vague spots on posterior portion brown-cinereous; the median vitta extending from pronotum to the dark brown scutellum and on the disk confluent with the large sublateral vitta which extends from humerus to posterior callus, the supra-alar spot not separate; pleura dark cinereous. Tergites with no cinereous pollen, quite shining, the yellow margins linear, venter lightly cinereous, the yellow margins narrow. Legs all black, femora not cinereous and without pile. Wings hyaline, second submarginal cell four times as long as wide, sections of third vein equal, the anterior branch ending at wing-tip, sections of fourth vein 1 : 4 : 5, of fifth vein 5 : 4; alulae whitish, halteres whitish with fuscous cap.

Female.—Front about one-fifth longer than wide, parallel-sided, brown pollinose behind, dark cinereous in front to the depression, face and narrow cheeks cinereous, upper occiput brownish, dark cinereous below, weals confined to lower occiput; proboscis slightly over twice the head-height, straight, palpi one-fourth as long as proboscis, thin. Thoracic pattern extensive, dark brown, the middle vitta beginning full width at the brownish pronotum and attaining scutellum as a narrowed stripe, the sublateral vitta broad, touching humeri, indented at suture and evanescent at posterior calli; the humeri, sides, four merging spots along hind margin, and scutellum dark cinereous; the intervittal lines brownish.

Types: Two males, seven females, from the Eastern part of Barton Flats, San Bernardino Mountains, California, elevation 6,250 feet, 3–21 September, 1944.

Oligodranes eremitis, n. sp.

Male.—Length 2.4 mm. Front and face snowy white, cheeks and occiput uniformly pure cinereous, face with a row of eight very short hairs almost to antennae, hairs of lower occiput short and scattered;

antennae black, thinly cinereous, basal joints equal, globular, third joint slender, rather oblong, parallel-sided, three times as long as deep, scarcely excavated at tip, the thorn and setule microscopic; proboscis slender, nearly straight, three times head-height; palpi very thin, yellow, about one-eighth as long as proboscis. Thorax nearly bare, cinereous in front of suture except for two narrow brownish vittae and a faint presutural spot, disk light brown, in the middle meeting the suture, on the sides and above the posterior calli cinereous; pleura cinereous, scutellum brown except extreme angles. Abdomen with short scattered hairs, viewed from front blackish with moderately broad light yellow margins on segments, viewed from back largely cinereous with brownish dorsal spots and pale margins, venter cinereous with narrow pale yellow interstices. Femora blackish, lightly cinereous, knees, tibiae and all of tarsi fuscous. Wings hyaline, veins thin, fuscous, paler basally, third vein ratio about 1 : 2 : 2, the anterior branch ending at wing-tip, fourth vein 1 : 2.7 : 3, fifth vein 2 : 1, anal petiole longer than anterior cross-vein; halteres whitish.

Female.—Front uniformly cinereous, nearly as wide as long, slightly narrowed posteriorly, occipital weals long and strong, upper grooves shallow, oral opening yellow in middle. Thorax all cinereous, not vittate but with a change in shade of the pollen where the anterior vittae and discal spot of the male are located, scutellum cinereous. Abdomen cinereous, first segment and apical and side margins of others widely pale yellow, with only faintest indication of the dark basal spots which give the impression when viewed from certain angles of being subinterrupted medianly. Tarsi and apex of tibiae blackish. Veins mostly yellow.

Type and allotype: Yucca Valley, San Bernardino County, California, 5 October, 1934. *Paratypes:* Two males from near Adelanto, California, 23 May, 1945; one male and two females from near Phelan, California, 28 June, 1945; three males, Piute Butte, Western Mojave Desert, California, 24 April, 1946. The paratypes have darker legs than the types. A female from Cathedral Canyon, near Palm Springs, California, 2 April, 1945, has shorter third antennal joint and may represent a closely related species. *Eremitis*, a desert inhabitant.

Oligodranes instabilis, n. sp.

Male.—Length 2.75 mm. Close to *O. cinereus*, differing from the description of the male as follows: Postocellar grooves separate until near neck, the weals reaching two-thirds the way up; eyes contiguous two-thirds the distance to the antennae, ocellar triangle black, antennae black; proboscis twice the head-height, palpi one-sixth as long as proboscis. Thorax only moderately cinereous, with faint indications of two dark gray median vittae. Abdomen thinly cinereous, subshining, wholly black including incisures. First vein reaching apical fourth of wing, second vein gently curved at end, third vein ratio 3 : 2 (in one specimen 3 : 1), costal ratio between first and third veins usually 1 : 1.3 : 1.

Female.—Front slightly brownish, one-half longer than width at ocellus; mesonotum cinereous with very faint brownish tone on disk;

abdomen varying from almost wholly honey-yellow to piceous with wide yellow incisures.

Types: Seventy-two specimens taken on flowers of *Geraea canescens*, near Truckhaven, midway the West side of Salton Sea, California, 3 April, 1946. Of these 13 are normal males with closed discal cell; 59 are females of which 41 are normal, 3 have the discal cell open in the left wing, and 8 in the right wing, and 7 open in both wings as in *Apolysis*. Sometimes the branch of the third vein is disconnected and some specimens have extra crossveins near the anterior crossvein. This fluctuation in the venation has suggested the species name, *instabilis*, Latin, inconstant.

Oligodranes lasius, n. sp.

Figure 9

Male.—Length 4 mm. Ground color black, pile long abundant and white. Front with parted silvery white hairs, face pilose almost to antennae, occiput cinereous, darker above, whitish pollinose below, heavily pilose; basal joints of antennae cinereous, the first joint one-half longer than the quadrate second and furnished with short silvery white hairs above, third joint rather oblong, one-half longer than the two basals and about three times as long as deep, emarginate above apex, no visible style; proboscis 2.5 times head-height, nearly straight, palpi slender, about one-fourth as long as proboscis. Shoulder triangles of white-cinereous pollen large, pointed behind, the mesial sides parallel and clearly delimited; pile moderately sparse on disk of notum but bunched on pro- and mesopleura and above notopleural suture, scutellar pile retrorse. Abdomen densely cinereous, base of segments black, venter cinereous. Legs more or less cinereous becoming darker distally, black with tips of femora yellowish, coxae and femora white-pilose. Wings glassy hyaline, veins fuscous at base and piceous apically, sections of third vein equal, the anterior branch ending at wing-tip, fourth vein ratio 2 : 3 : 4, fifth vein 2 : 1, posterior crossvein straight or very slightly sigmoid, sometimes with a short spur at middle, petiole of anal cell shorter than anterior crossvein, ambient vein complete; knob of halteres blackish except at base.

Female.—Hairs of body greatly reduced, face bare. Upper occiput and posterior two-thirds of front golden brown, anterior third of front golden cinereous, face and cheeks yellow, occipital weals not developed but postocellar triangular grooves strong. Disk of thorax rich brown becoming cinereous on humeri, sides, rear and scutellum, with two dark brown strong median vittae on anterior half, with broad sublateral vittae notched at suture and with a round supra-alar spot.

Types: Eleven males and four females, from the East end of Barton Flats, about 6300 feet elevation, San Bernardino Mountains, California, 1 to 12 September, 1944. One of the females has a remarkable deformity of the antennae. The right antenna has only the two basal joints which are a little subnormal in size. The left antenna has a lengthened first joint, a somewhat swollen and irregular second joint, the upper outer corner of which bears the transferred third joint of the right antenna, but it is broadly rounded and shorter than wide. From the end of the

second joint arises the greatly shortened and broadened third joint which is pyriform in shape and only one-half longer than deep. One of the males has the anal cell widely open. A headless male from Blewett Pass, Washington, 28 June, 1924, appears to be very close to this species. *Lasius*, from Greek, shaggy with hair.

Ologodranes longirostris, n. sp.

Figure 2

Male.—Length 2.6 mm. Front and upper face usually light golden, sometimes silvery, sides of face bare, cheeks with straggling hairs, occiput brown gray pruinose, weals strong and restricted to lower half, hairs short, sparse and growing up; third joint of antennae 2.5 times as long as deep, the notch short and deep, thorn strong; proboscis slender, curving, three or four times the head-height, palpi slender, about one-eighth as long as proboscis. General color of mesonotum light golden brown before suture and rich brown behind, the two vittae weak and narrow in front, strong and almost black behind suture, stopping at presutural area, in addition to the widely interrupted dark brown sublateral vitta a posthumeral brownish mark and a round supra-alar spot, the posterior sublateral mark more or less continued to corner of scutellum; pleura cinereous with light brownish tone, sternopleura with few small hairs. Abdomen brownish black, the light yellow fasciae of segments two to four about one-fifth the segment, of posterior segments very narrow, the fasciae not sharply limited anteriorly; upper edge of lower pygidium with broad inflexed lobe. All hairs of legs short. Wings hyaline, veins fuscous, paler at base, costal ratio of first to third veins 1 : 2 : 1, anterior branch ending at wing-tip, sections of fourth vein 1 : 2 : 3, of fifth vein subequal, first vein ending opposite basal fourth of second submarginal cell; rim of allulae white, halteres yellowish, slightly infuscated above.

Female.—Head golden brown, front nearly square, occipital weals strong, placed low, curving around and meeting below neck, post-ocellar grooves weak. Thoracic pattern much like that of male, the general light brown color of intervittae extending to prothorax, the pair of median vittae not attenuated anteriorly.

Types: Six males and thirty-four females, collected at the East end of Barton Flats, San Bernardino Mountains, California, elevation about 6400 feet, 31 July, 1942, and 3 to 21 September, 1944.

Oligodranes loricatus, n. sp.

Figure 6

Male.—Length 2.8 mm. Very close to *O. bifarius* and *trifidus*, agreeing with the description of the latter except as follows: Third antennal joint short and broad, obpyriform, scarcely twice as long as deep, widest beyond middle. The white cinereous pattern of mesonotum continuous across front and meeting the cinereous sides, with backward directed prongs on the dorsocentral lines to the transverse suture. The black pattern of the disk includes a posthumeral round spot formed by the cinereous transverse suture and the extension of the shoulder mark and a large mesial fork, the tines of which are faintly indicated

under the thick coating of white pollen. Upper edge of lower pygidium with a broadly rounded lobe occupying more than one-third the length. Sections of fourth vein proportioned 1 : 4 : 4, anal petiole not longer than anterior crossvein; allulae and rim white, knob of halteres white.

Female.—Entire front light brownish cinereous, occipital weals strong, extending halfway; palpi about one-third as long as proboscis. The pair of median vittae, the double sublateral and single small supra-alar spots seal brown, merging into the light brown-cinereous interspaces. Tergites cinereous only at posterior angles. Rim of alulae white; knob of halteres white.

Holotype: Male, collected in Sheep Creek Canyon on the Northeast base of Mount San Antonio, California, 24 May, 1945. *Allotype:* collected near Camp Baldy, on the South slope of the same mountain, 1 July, 1945. *Paratypes:* five males taken with the holotype; a male and two females taken with the allotype; a male from the East part of Barton Flat, 18 June, 1945; and a female from Mountain Home Creek, 4 July, 1938, on *Phacelia distans* (Timberlake), the last two localities in the San Bernardino Mountains, California.

There is some variation in the white cinereous pattern of the thorax of the male, an extreme specimen has a sagittal stripe extending to center of disk, with the long tines of the mesial fork showing black. *Loricatus*, Latin, clothed in mail.

Oligodranes lugens, n. sp.

Male.—Length 2.4 mm. An opaque black species without ornamentation. Face wholly bare, its sides parallel, brownish, beard of cheeks short and scant; eyes contiguous for three-fourths the frontal length; basal joints of antennae equal, third joint elongate pyriform, nearly three times as long as deep, the preapical notch deep, thorn distinct. Thorax with three vague brownish spots on collar, brown-pilose behind humeri. Legs without cinereous cast. Wings slightly infumated, veins black to base, second submarginal cell opening at tip of wing, sections of third vein 3 : 2, of fourth vein 1 : 3 : 3, of fifth vein about 2 : 1, anal petiole longer than anterior crossvein, ambient vein very weak; halteres and alulae black.

Female.—Nearly bare, the scattered hairs and bristles pale; wholly black, the knob of halteres pale yellow. Front parallel-sided, about one-sixth longer than wide, back of head smooth, without weals or grooves.

Holotype and allotype: Collected on the Ortega Highway, Southwest of Lake Elsinore, California, 29 June, 1942. *Paratypes:* Seven additional males taken with the types; two males, Sheep Creek Canyon, near Phelan, California, 24 May, 1945. *Lugens*, Latin, wearing mourning apparel.

Oligodranes maculatus, n. sp.

Figure 1

Female.—Length 4.2 mm. Head and body heavily white-cinereous pollinose, abdomen strongly fasciate with yellow; thorax marked with velvet-black spots as follows: a pair of large round presutural spots, a

large supra-alar spot shaped like a thick inverted J, a large obcordate prescutellar spot. a lunate mark at base of scutellum; second abdominal segment velvet-black except margins and a cinereous dot in middle, segments three and four except wide cinereous sides and a cinereous interruption at middle, segments five and six each with a pair of smaller sublateral black spots. Front about as wide as an eye, tapering behind, 1.5 times as long as width at antennae, face with close white beard, occiput densely white-pilose, weals large and strong; antennae black, lightly cinereous, the first joint twice as long as second and with a few hairs above, third joint strap-like, scarcely tapering, four times as long as deep, the preapical thorn and sulcus small; proboscis four times head-height, palpi one-seventh as long as proboscis. Pile of thorax moderate, pleura heavily pollinose, only the mesopleura pilose, scutellar disk with erect hairs. Venter heavily cinereous, the yellow fasciae broad. Coxae cinereous and pilose, femora hairy, blackish, the knees yellow, tibiae yellow with apical fourth blackish, tarsi blackish, the basal half of middle metatarsi yellowish. Wings hyaline, veins light fuscous, costal ratio between first and third veins 1 : 1.2 : 1.2, third vein forked before end of first vein, second submarginal cell wider than marginal, ratio of fourth vein 1 : 3 : 3, the fifth vein 4 : 3, anal petiole equal to anterior crossvein, ambient vein stopping at fifth vein; alulae and halteres white.

Holotype: Palm Canyon, at Palm Springs, California, 3 April, 1925, on *Encelia*, collected by Professor P. H. Timberlake for the Citrus Experiment Station.

This is the most distinctively marked species of the genus.

Oligodranes montanus, n. sp.

Male.—Length 3 mm. Front satiny brown, face bare, cheeks with few hairs, mouth opening glistening black, occipital hairs scattered and rather short; eyes contiguous two-thirds the frontal length; first antennal joint smaller than second, third joint obovate, wide, twice as long as deep, preapical notch deep, with distinct thorn and setule; proboscis 2.5 times head-height, slender, nearly straight, palpi slender, one-seventh as long as proboscis. Disk of thorax blackish, with two median black vittae and sublateral black vitta interrupted into two round spots, also a smaller black supra-alar spot, shoulders broadly cinereous confluent with the wide gray sides, posterior portion of notum less definitely marked with four brownish cinereous rounded spots, a pair before scutellum and one before each callus; pleura dark cinereous, scutellum black, the disk with scattered hairs. Abdomen black, subshining. Legs wholly black. Wings with slight yellowish tinge due to microtrichiae, first basal cell longer than second by more than the length of the anterior crossvein, costal ratio between first and third veins 1 : 1.5 : 0.9, third vein ratio 5 : 4, the branch ending just beyond wing-tip, ratio of fourth vein 1 : 3.5 : 3, of fifth vein 2 : 1, anal petiole equal to anterior crossvein, ambient vein thin but complete; alulae white, knob of halteres yellow.

Female.—Upper part of head brownish cinereous, front one-fourth longer than wide, parallel-sided, weals strong. Mesonotum largely

cinereous, marked with brown on a pair of narrow median vittae with an included sagittal vitta reaching the scutellum, and a broader interrupted sublateral vitta and small round supra-alar spot, scutellum cinereous. Abdomen blackish, with distinct yellow incisures.

Types: Two males and six females, collected by Professor P. H. Timberlake at Mill Creek, San Bernardino Mountains, California, at 6000 ft. elevation, 20 June, 1937, on *Penstemon Grinnelli*; types in Citrus Experiment Station.

Oligodranes neuter, n. sp.

Male.—Length 2.7 mm. Black, rather thinly coated with dark cinereous but denser and lighter on anterior half of thorax; loosely pilose. Front reaching thirdway between antennae and ocellus, viewed from below the face and front lose their white satiny sheen and appear black, ocellar triangle and mouth opening black; basal joints of antennae globular, the first slightly smaller, lightly cinereous, third joint twice as long as basal two, and twice as long as deep, widest at three-fourths, apex oblique with definite preapical blunt thorn; proboscis thin, twice the head-height, slightly curved, palpi one-fourth as long as proboscis, thin, black. Disk of thorax centrally and sublaterally subshining black, a rounded presutural sublateral opaque black spot, a pair of oval cinereous spots before scutellum, scutellum thinly cinereous, its disk almost bare. Abdomen black, thinly cinereous, no fasciae. Legs all black, pulvilli sordid white, the hairs under the femora equal in length to their diameter. Wings hyaline, veins thin, dark, slightly paler but not yellowish at base, second vein ending opposite middle of second submarginal cell, sections of third vein proportioned 3 : 2, the anterior branch ending at wing-tip, of fourth vein 1 : 4 : 4.5, of fifth vein 5 : 4, anal petiole equal to anterior crossvein, ambient vein thin; halteres white.

Female.—More heavily pollinose, nowhere subshining, fully as pilose the thoracic marks brown, consisting of two narrow anterior vittae, a median narrow posterior vitta, a presutural, a postsutural, and a supra-alar oval spot, scutellum cinereous; abdomen black, side angles widely cinereous, incisures yellow, first segment cinereous, venter cinereous with yellow incisures. Front parallel-sided, with square brown spot before ocellus, occipital weals low-placed and rather weak, postvertical grooves shallow; palpi nearly half the length of proboscis; third antennal joint broadly oval, the preapical excision deep, the thorn erect and curved, the adjacent style minute.

Type and allotype: Joshua Tree National Monument, San Bernardino County, California, 21 April, 1944. *Paratype:* A female, Morongo Valley, San Bernardino County, California, 20 April, 1944. *Neuter*, Latin, neither the one nor the other.

Oligodranes palpalis, n. sp.

Male.—Length 1.65 mm. Very similar to *O. analis*, but with reduced hairs, face bare, frontal triangle of male and first antennal joint with only a few microscopic hairs, very few hairs behind humeri; no chitinization of anal vein. Proboscis longer than head, palpi nearly as long as head-height, very slender. Second submarginal cell narrow, sections of

third vein 1 : 0.6, of fourth vein 1 : 2 : 4, of fifth vein 5 : 4, anal petiole equal to anterior crossvein; apical part of knob of halteres luteous.

Female.—Nearly bare, front square, occipital weals and grooves undeveloped. Scutellum with about ten rather stiff black marginal hairs. Ventral segments brown with narrow yellow margins.

Holotype and allotype: Blewett Pass, Chelan County, Washington, 17 July, 1920. *Paratypes:* Two topotypic females; two females from Mount Hood, Oregon, 29 July, 1921; one male, Logan Falls, Glacier Park, Montana, 14 July, 1935, and one male from Lake MacDonald, 13 July, 1935; a pair from Sheep Creek Canyon, San Bernardino County, California, 24 May, 1945, the female having the sides of the mesonotum dark cinereous instead of opaque black.

Oligodranes panneus, n. sp.

Male.—Length 2.5 mm. Face with two hairs near middle, occiput cinereous, weals strong and extending halfway, hairs sparse, post-ocellar grooves forming a deep V; eyes contiguous halfway to antennae, ocellar triangle cinereous; basal joints of antennae equal, third joint oblong, nearly three times as long as deep, preapical sulcus very small; proboscis twice head-height or less, nearly straight, palpi one-fifth as long as proboscis. General color of thorax dark brown, the anterior fourth cinereous continued posteriorly to prescutellar area as two dorsocentral stripes which follow the transverse suture to the grayish sides and thus enclose a pair of presutural rectangular brown marks, the median brown stripe continued forward to the pronotum as two thin vittae through the cinereous part and back to enclose a small narrow cinereous mark in front of scutellum; pleura dark cinereous, mesopleura with only about five small hairs. Abdomen dark brown, the venter and apical segments lightly cinereous, incisures not differentiated but the posterior half of tergites may be cinereous. Legs blackish, nearly bare, knees very narrowly testaceous. Wings slightly flavescent, veins fuscous to base, first basal cell longer than second by more than length of anterior crossvein, costal ratio between first and third veins 1 : 1.5 : 1, second submarginal cell subequal to its petiole, sections of fifth vein subequal, anterior crossvein at two-fifths the discal cell, ambient vein complete; alulae white, knob of halteres yellow.

Female.—Dull brownish cinereous. Front uniformly yellowish cinereous, slightly longer than width at antennae, cheeks as wide as basal antennal joints. Notum with two narrow faintly brownish median vittae. Abdomen more densely cinereous than male, with distinct yellow fasciae. Costal ratio of marginal and submarginal cells 1 : 1.3 : 1.

Types: Five males and one female, two miles South of Travertine Rock on West side of Salton Sea, California, 29 May, 1936, on flowers of mesquite, collected by P. H. Timberlake and F. R. Platt. Types in collection of Citrus Experiment Station. *Panneus*, Latin, ragged, referring to the irregular edge of the shoulder stripes.

Oligodranes parkeri, n. sp.

Male.—Length 1.75 mm. General body color dark brown, pollen brownish cinereous on pleura and between the chocolate brown notal

pattern, humeri yellowish. Front and face whitish, sides of face as wide as basal antennal joints, bare, cheeks with scattered small hairs, occiput flat; basal joints of antennae equal, globular, third joint twice as long as basals and 2.5 times as long as deep, broadest at three-fourths, blunt, tipped with a small thorn and microscopic preapical setule, the emargination very small; proboscis twice head-height, nearly straight, palpi minute, thin, blackish. Scutellum brown, margined with subcinereous. Abdomen not cinereous, base of segments dull black, first segment and apical third of others yellowish. Legs blackish, the knees a little paler. Wings hyaline, veins thin, dark to base, first submarginal cell narrow, 3.5 times as long as wide, opening at wing-tip, third vein ratio 3 : 2, fourth vein 1 : 3 : 4, the last two sections slightly sigmoid, the first posterior cell about twice as wide on the margin as the second posterior, petiole of anal cell twice as long as anterior crossvein, ambient vein very thin beyond fourth vein; halteres yellowish white.

Female.—Length 2.5 mm. Front brownish cinereous, slightly longer than width at antennae, narrowed behind, center of mouth opening black, occipital weals strong, postocellar grooves distinct; proboscis slightly curving down. The dark gray of scutellum encroaching more on the brown pattern than in male. Anterior crossvein at basal fifth of discal cell and about equal to anal petiole; knob of halteres somewhat brownish in front.

Holotype: A male from Globe, Arizona, 21 April, 1938, collected by F. H. Parker. *Allotype* and a female *paratype* from San Carlos, Arizona, 30 April, 1938, also taken by Mr. Parker. Types in Melander Collection.

This species is readily recognized by the inverse arrangement of the notal vittae. The other species with bivittate thorax have the center stripe paler than the adjacent vittae. In *Parkeri* the central stripe is brown and the adjacent vittae are cinereous. The species is named for its discoverer, Frank H. Parker, in recognition of his enthusiasm as a student of Arizona insects and of his care in collecting and mounting the Bombyliidae.

Oligodranes polius, n. sp.

Female.—Length 2.1 mm. Heavily whitish-blue cinereous, head with faint brown tint above, mesonotal disk posteriorly with similar brownish median spot reaching on to scutellum and on each side with short similar postsutural sublateral vitta, also two faint indications of the presutural median vittae. Front nearly parallel-sided, face with full row of about seven hairs, cheeks narrower than basal antennal joints, occipital weals long and strong, postvertical grooves weak, mouth opening black; antennae cinereous, basal joints subequal, above with a few microscopic hairs, third joint oblong, twice as long as basals, three times as long as deep, apically scarcely excavated, the style microscopic and directed forward; proboscis three times head-height, slender, curving slightly down, palpi one-eighth as long as proboscis, black. Thorax nearly bare, scutellar disk bare, apical fringe short. Abdomen white pubescent, cinereous black, first segment and incisures whitish. Legs not pilose, cinereous black, knees narrowly and base of anterior tibiae reddish. Wings whitish hyaline, veins whitish at base

and piceous beyond furcations, costal cell opalescent, first basal cell longer than second by length of anterior crossvein, costal ratio of marginal and submarginal cells 1 : 1.5 : 1, second vein ending opposite middle of second submarginal cell, ratio of third vein 5 : 4, the anterior branch ending at wing-tip, fourth vein 1 : 2.5 : 3, fifth vein 3 : 2, anal petiole longer than anterior crossvein, ambient vein stopping at fourth vein, alulae and calypteres white.

Holotype: Palm Springs, California, 4 April, 1945. *Paratypes:* two females, Aquila, Arizona, 12 May, 1942. *Polius*, Greek, whitish gray.

A male collected in Magnesium Springs Canyon, eleven miles East of Palm Springs, 4 April, 1946, appears to belong to this species and has been included in the key as such. It differs from the females in lacking the postsutural median faint infuscation, the two faint median vittae being continued to the prescutellar area and separated by cinereous pollen; cheeks as wide as basal antennal joints, eyes contiguous halfway to antenna. Legs black. Anterior crossvein nearer middle of discal cell, the ratio of fourth vein 1 : 1.2 : 3.2, sections of third and fifth veins subequal.

Oligodranes pulcher, n. sp.

Figure 5

Male.—Length 2 mm. Black, largely cinereous with characteristic black thoracic markings; sparsely white-pilose. Front and facial orbits silvery white, remainder of face narrowly white with polished black oral margin, ocellar triangle black; eyes contiguous two-thirds the way to the antennae; basal joints of antennae equal, third joint elongate pyriform, twice as long as deep, widest beyond middle, the preapical emargination very small, thorn minute; proboscis slender, nearly straight, palpi linear. Thorax light cinereous on front, sides extending up the suture, scutellum, four more or less confluent spots on hind margin, two vittae, a deep anterior notch on the black central stripe, and the pleura; otherwise the notum is black, i.e., a strong median vitta widely notched in front and linear behind, and an irregular sublateral vitta notched at suture and confluent with the usual supra-alar spot; scutellum with a few erect hairs, a small bunch of hairs behind humeri. Base of tergites black, sides and margins cinereous, when viewed from back the incisures appear narrowly white, venter cinereous, the hind margins of the segments weakly pale. Legs without pile. Wings hyaline, veins thin, black, fuscous at extreme base, costal ratio of marginal and first submarginal cells 1 : 1.2, third vein ratio 4 : 3, the branch ending just before wing-tip, fourth vein 1 : 2.75 : 3, fifth vein 3 : 2, anal petiole equal to anterior crossvein, ambient vein very weak; knob of halteres white, often with blackish tip.

Female.—Pubescence sparse, face bare. Median vitta of thorax not notched in front but spreading toward humeri, the bounding cinereous stripes swerving toward humeri, somewhat duller than in male, sublateral vitta indented or broken at suture the posterior part quite reaching scutellum; abdomen blacker than thorax, opaque, venter lightly cinereous. Front slightly longer than wide, brown, a brown V-shaped mark on occiput behind ocelli, weals distinct.

Holotype and allotype: Palm Springs, California, 24 April, 1944. *Paratypes:* Seven males and twenty-five females taken with the types; one male, Morongo Valley, 19 April, 1944; five males and one female, Pala, 6 June, 1945; two males and four females, Oak Grove, 8 May, 1945; one female, Northwest Borego Desert, 3 May, 1945; four males, Verdemont, near San Bernardino, 1 May, 1946 and another, 13 May, 1946, all in California.

Oligodranes pullatus, n. sp.

Male.—Length 2.3 mm. Face with few hairs, occiput loosely pilose, weals strong, on lower half, postvertical notch deep; third joint of antennae curved above, 2.25 times as long as deep, the notch and thorn strong; proboscis twice head-height, slender, slightly curving down, palpi slender, one-fourth as long as proboscis. Pleura cinereous. Sides of abdomen thinly cinereous, venter cinereous, dorsal incisures linear, hairs long and scattered. Legs wholly black, with cinereous coating, femoral hairs sparse. Wings hyaline, first basal cell distinctly longer than second, second submarginal cell at tip of wing, four times as long as broad, sections of fourth vein proportioned 1 : 2.5 : 2.5, anal petiole twice as long as anterior crossvein, no ambient vein.

Female.—Front one-fourth longer than wide, nearly parallel-sided, sides of face bare, occipital weals strong, extending up two-thirds, post-vertical grooves weak; third antennal joint shorter and thicker than in male; proboscis about three times head-height, palpi one-sixth the proboscis length. Notum mostly brownish, the double median dark brown vittae divided by a paler brown sagittal stripe and stopping on the grayish prescutellar area. Abdomen black, the distinct incisures pale yellow, base of sternites black and slightly cinereous.

Holotype and allotype: Cajon, California, in the pass between the San Gabriel and San Bernardino Mountains, 28 June, 1945. *Paratypes:* One female, Sheep Creek Canyon in Western San Bernardino County, California, 24 May, 1945; two males and twelve females, Mountain Home Canyon, San Bernardino Mountains, California, 21 June, 1945, on flowers of the Yerba Santa, *Eriodictyon trichocalyx*, the males having the frontal triangle golden. *Pullatus*, Latin, wearing black clothes.

Oligodranes retrorsus, n. sp.

Figure 12

Male.—Length 6 mm. Heavily encrusted with white pollen, densely white-pilose, no vittae but abdomen strongly fasciate. Ocellar triangle cinereous, front and larger part of face glistening silvery white, which appears ivory white when seen from front, face as broad as half the length of the third antennal joint, closely bearded quite to antennae, mouth opening black; eyes contiguous halfway; basal joints of antennae short cylindrical, equal, third joint elongate, four times as long as deep, widest at middle and then tapering, truncate at tip and with terminal minute thorn and setule, with fuscous annulus at base; proboscis one-half longer than head-height, stout, straight, porrect, palpi less than one-eighth the length of the proboscis, black, with a few white hairs. Legs cinereous, knees yellow, coxae and outer sides of femora pilose, claws and pulvilli nearly as long as last tarsal joint. Wings hyaline,

base of the bicolored costa with golden fringe, veins yellow, apically dark, sections of third vein equal, branch arising steeply and ending at wing-tip, anterior crossvein at or just before middle of discal cell, anal petiole very short, ambient vein complete; alulae white, halteres yellow.

Female.—Head small, proboscis twice the head-height or longer, body pubescent rather than pilose, the hairs longest on lower occiput, face with scattering hairs. Front broad, as wide at antennae as length, golden pollinose, occipital weals distinct, postvertical grooves forming the upper part of a broad V. Pollen of notal disk slightly golden. Basal fourth or less of tibiae yellowish, claws and pulvilli normal. First abdominal segment yellow, sometimes more or less of base of abdomen yellowish.

Type and allotype: Near Whitewater, California, 27 October, 1934. *Paratypes:* Four males and two females taken with the types; seven females, Quail Spring in the Joshua Tree National Monument, California, 5 October, 1934; one female, Cabazon, California, 7 November, 1934; one female, Piute Butte, Mojave Desert, California, 24 April, 1946. On the same trip when the types were collected Professor Timberlake obtained 24 specimens on *Aplopappus acradenia*, and in the same general region, on 23 November, 1933, he had taken it on *Chrysothamnus paniculatus*. *Retrorsus*, Latin, turned backward, i.e., hairs of scutellum.

Oligodranes scapularis, n. sp.

Male.—Length 1.5 mm. Cheeks with straggling white hairs, occipital weals undeveloped; third joint of antennae oval, widest beyond middle, twice as long as greatest depth, notch and thorn distinct; proboscis one-half longer than head-height, palpi one-third as long as proboscis. Thorax mostly dull black, seen from above the prothorax, shoulders and a narrow sagittal V, all connected in front, cinereous, the shoulder triangles continued as a line to back part of notum, sides of notum cinereous extending upwards at transverse suture, a pair of prescutellar spots lightly cinereous; seen from behind, two broad dark gray vittae extending forward from corners of scutellum; pleura dull cinereous; about ten short white scutellar hairs, hairs extending from sides of notum long and white. Abdomen black, sides and venter cinereous, dorsal incisures very narrowly cinereous, ventral incisures narrowly yellow; abdominal hairs scattered. Coxae cinereous, legs otherwise all black. Wings hyaline, marginal cell dull, veins blackish, first basal cell a little longer than second, second submarginal cell three times as long as wide, sections of third vein 1 : 0.6, the branch ending slightly before wing-tip, fourth vein about 1 : 2 : 4, fifth vein 1 : 0.8, anal petiole slightly longer than anterior crossvein; halteres white, base dusky.

Female.—Head brownish cinereous above, cinereous below; front one-half longer than wide, very slightly narrowed behind, occipital weals very weak, postvertical grooves shallow, hairs of cheeks sparse and short. General color of thorax brownish cinereous, humeri, scutellum and pleura cinereous, two narrow black vittae extending two-thirds, the velvety black sublateral vittae broken into two spots at transverse suture, the anterior round, the posterior elongate triangular. Abdomen when viewed from behind black with distinct white incisures, from the side the segments lightly cinereous.

Holotype and allotype: Oak Grove, on the North base of Mount Palomar, San Diego County, California, 8 May, 1945. *Paratypes:* Three males and nine females, taken with the types; one male and six females, Verdemont, near San Bernardino, California, 25 April, 1946; and four females, same locality, 1 May, 1946; one male, Riverside, California, 26 April, 1937, the last taken by Professor Timberlake on *Cryptanthus intermedia* (C. E. S.). *Scapularis*, referring to the long shoulder marks.

Oligodranes scapulatus, n. sp.

Male.—Length 2.5 mm. Body deep velvet black, notum with long cinereous shoulder triangles. Front rather dull silvery, face with four hairs, cheeks as wide as basal antennal joints, occiput subshining black, weals small, postvertical grooves rather deep; eyes contiguous two-thirds the distance to antennae; first antennal joint smaller than second, third joint broadly elliptical, about twice as long as deep, sulcus and thorn evident; proboscis less than head-height, thick, straight, palpi slender, nearly as long as proboscis. Thoracic hairs long, delicate and straggling, but more bunched behind humeri, scutellar disk bare; a narrow sagittal dark cinereous stripe between the shoulder triangles which reach two-thirds to the suture line; pleura black, mesopleura with a few hairs. Hairs of abdomen fine and scattered. Legs wholly black. Wing veins uniformly blackish, costal ratio between first and third veins 1 : 0.5 : 0.75, sections of third vein 6 : 5, the branch ending before wing-tip, fourth vein 1 : 3 : 2.5, fifth vein 3 : 1, anal petiole equal to anterior crossvein, ambient vein evanescent beyond third vein; alulae sordid beyond the black base, halteres blackish.

Female.—Upper part of head brownish, lower part dark cinereous, front one-fourth longer than breadth at antennae, the anterior part becoming cinereous, weals very small. Notum deep brown, marked with cinereous shoulder triangles, but without the sagittal cinereous stripe, sides with cinereous triangles extending up suture, posterior calli and a pair of vague prescutellar spots somewhat cinereous, pleura dark cinereous. Abdomen black, incisures very narrowly yellowish.

Types: Five males and ten females, collected by P. H. Timberlake at The Gavilan, Riverside County, California, 13 June, 1938, on Greasewood, *Adenostoma fasciculatum*. Types in collection of Citrus Experiment Station.

Oligodranes sipho, n. sp.

Figure 4

Male.—Length 3 mm. A well marked species easily recognized by the three white-cinereous triangles on front edge of thorax, white pilose body, long thin proboscis and large discal cell. Sides of face with about eight long hairs, occipital weals rather strong for male; third antennal joint nearly three times as long as deep, elongate obpyriform, with obliquely truncate notch and strong thorn, behind which is a minute setule. The shoulder triangles include the humeri across to the bifurcate forward extension of the opaque jet-black disk and projecting back halfway to the transverse suture, the sagittal triangle narrower, sides

of notum with cinereous triangles extending up suture; prothorax, pleura and coxae cinereous; scutellum jet-black, fringed with about twenty long white hairs. Abdomen with long hairs, dorsum black, venter cinereous, sides of tergites more or less cinereous; upper part of pygidium with median groove, lower part with short thick conical caudal projection. Legs wholly black, anterior femora with scattering pile. Wings glassy hyaline, veins blackish, the posterior basal veins light fuscous toward base, first basal cell much longer than second, costal ratio of marginal and first submarginal cell 1 : 1.5, second submarginal cell ending at wing-tip, last section of fifth vein usually as long as posterior crossvein, anal petiole longer than anterior crossvein, no ambient vein; halteres yellow, dusky above.

Female.—Pile of body reduced in length. Front 1.2 times as long as wide, parallel-sided, sides of face with scattering hairs to antennae; proboscis fully four times head-height, slender and curving down, palpi about one-sixth as long as proboscis. Notum quadrivittate with brown, the discal intervittae light brownish cinereous, sides, prescutellar area and scutellum becoming more cinereous, the double median vittae reaching prescutellar area, the lateral vittae notched at transverse suture, a small round blackish supra-alar spot. Yellow margins of abdominal segments not sharply limited in front, tergites basally black, sternites cinereous. Last section of fifth vein slightly longer than posterior crossvein.

Holotype and allotype: Oak Grove, at North Base of Mount Palomar, California, 9 May, 1945, on blue flowers of *Phacelia*. *Paratypes:* Twenty-four males and forty females, collected with the types and at Temecula, California, 10 May, 1945, and at Oak Glen, California, 2 July, 1945, also on a blue *Phacelia*, and at Mountain Home Canyon in the San Bernardino Mountains, California, 9 May, 1946. *Sipho*, Latin, a small tube used for sucking liquids.

Oligodranes speculifer, n. sp.

Male.—Length 4.75 mm. Densely coated with white-cinereous pollen, pilose. Beard extending almost to antenna, sides of face and cheeks half as wide as length of third antennal joint; eyes contiguous halfway from ocellus to antennae, the frontal triangle wider than high, glistening white, ocellar triangle black; basal joints of antenna cinereous, with microscopic hairs above, the first joint a little longer than the spherical second joint, third joint black, 2.5 times the basal two, slender, four times as long as deep, slightly tapering on apical third, the apex with microscopic pit and point; proboscis three times head-height, slender, curving down and then curving up at tip, palpi vestigial, very thin, about one-eighth as long as proboscis. Thorax strongly pubescent, with longer retrorse pile posteriorly and on scutellum, two narrow bare stripes taking the place of the usual colored median vittae, marked with two pairs of polished jet-black spots, one supra-alar and round, the other at inner end of suture and subtriangular, mesopleura and sternopleura pilose. Abdomen long-pilose, thickly overlaid with gray white pollen, first segment and apical half of others whitish. Legs cinereous black except the yellowish knees, base and inside of tibiae and base of tarsi;

front coxae and front femora pilose, posterior femora pubescent, claws and pulvilli nearly as long as last tarsal joint. Wings hyaline, costa and veins to discal cell pale yellowish, blackish apically, ambient vein complete, posterior crossvein strongly sinuous, discal cell large and wide, second vein ending beyond middle of second submarginal cell, third vein ratio 1 : 1 : 1.2, the anterior branch ending at wing-tip, the three sections of fourth vein almost equal, fifth vein 2 : 1, anal petiole shorter than anterior crossvein; halteres white.

Female.—Pile and pubescence shorter. Front trapezoidal, width at antennae equal to length and one-half longer than width at ocellus; occiput wholly white-cinereous, the upper grooves forming a shallow wide V, the weals rather strong and extending nearly three-fourths to the vertex; proboscis more than three times the height of the small head. Claws and pulvilli somewhat smaller than in the male. Veins pale fuscous basally, discal cell normal, third vein ratio 1 : 1 : 1.5, fourth vein 1 : 1 : 2, fifth vein 5 : 4.

Holotype: Tahquitz Canyon, near Palm Springs, California, 23 April, 1944. *Allotype:* Three miles West of Palm Springs, 6 May, 1946, on Indigobush, *Dalea Schotti*. *Paratype:* A female taken with the allotype. This species belongs in a group with ***comosus*** and ***retrorsus***, characterized by the bicolored costa and elongate claws and pulvilli of the male. *Speculifer*, from Latin, ***speculum***, mirror, referring to the glistening notal spots.

Oligodranes togatus, n. sp.

Figure 7

Male.—Length 3 mm. White-pilose. Facial hairs confined to lower half; eyes contiguous two-thirds the frontal length; third antennal joint elongate reniform, twice as long as deep, slightly sulcate above tip, the thorn microscopic; proboscis less than twice head-height, nearly straight, palpi black, thin, one-fourth as long as proboscis. Thorax black, the shoulders white-cinereous, between them a median less dense part, the marginal cinereous pruinosity of mesonotum encroaching on the center of the disk giving a bluish cinereous tone in front of scutellum; when viewed from front the cinereous markings coalesce into an anterior semicircle. Abdomen mostly cinereous, base of tergites dark, venter with white incisures. Legs black, knees very narrowly reddish. Veins basally yellow, second vein ending beyond middle of second submarginal cell, sections of fifth vein usually subequal, anterior crossvein at two-fifths the discal cell, anal petiole shorter than anterior crossvein, ambient vein complete; halteres white.

Female.—Face, cheeks, anterior third of front, first antennal joint, humeri, scutellum, spot above front and hind coxae, knees, more or less of tibiae, first abdominal segment and wide posterior margins of others, and halteres, all bright yellow. Pollen of head and dorsum ranging from golden to cinereous, with corresponding coloration of pubescence, three sublateral brownish spots more or less evident on thorax, one presutural, one postsutural and one supra-alar. Proboscis rigid, porrect, face appearing nearly horizontal due to the absence of pollen on the oral margin at the cheeks, occipital weals and grooves undeveloped.

Holotype and allotype: Morongo, California, 28 September, 1944. *Paratypes:* Four males and one female, taken with the types; one male and one female from Quail Spring, 5 October, 1934; one male and ten females from Cactus Flat, San Bernardino Mountains, elevation 6,000 feet, 1 September, 1936, on flowers of *Chrysothamus stenophyllus* and *Gutierrezia lucida*, the last taken by Professor P. H. Timberlake (C.E.S.).

The male is very close to *O. colei* which occurs in the same locality, but the females are totally different, manifesting the same type of dimorphism as is found in *O. knabi*. Of course it is not certain that the two sexes belong together since they were not taken in copulation, though they both feed on the same flowers. In one male the posterior crossvein is sinuous in both wings. The Quail Spring female has the thorax largely cinereous. *Togatus*, Latin, wearing a cape.

Oligodranes trifidus, n. sp.

Figure 11

Male.—Length 3 mm. Body opaque jet black, the pile long, delicate and white. Third antennal joint with the preapical notch deep, the thorn stout and before it an evident setule; proboscis one-half longer than head-height, palpi slender, half as long as proboscis. The white-cinereous thoracic pattern consisting of broad shoulder triangles and a nearly parallel-sided or narrowly triangular sagittal stripe, separated by forward extensions of the opaque black disk, sides of notum with low cinereous triangle the apex on the transverse suture; pleura cinereous, sternopleura with loose pile. Upper part of pygidium flattened on each side of a median groove, lower part blunt with a small semicircular setulose expansion near middle of inside edge. Legs wholly black, but with cinereous coating. Wings pure hyaline, veins strong, first basal cell a little longer than second, costal ratio of marginal and submarginal cells 1 : 2 : 1, fourth vein 1 : 3 : 3.5, fifth vein 1 : 0.6, anal petiole slightly longer than anterior crossvein, ambient vein very thin; alulae whitish but base and rim black, the fringe white; stalk and upper side of knob of halteres usually black or blackish.

Female.—Hairs much shorter than in male. Head brownish cinereous above, more gray below, front square, slightly widened at antennae, occipital weals weak, postocellar grooves shallow; proboscis twice head-height, straight, palpi half as long as proboscis. Notum bounded by dull cinereous, the disk seal brown, with the two median vittae, two rounded sublateral and one smaller supra-alar spots quite black, scutellum dull cinereous with about fourteen marginal hairs. Upper side of abdomen black, lightly dusted, incisures yellow, cinereous triangles at sides of tergites, venter cinereous, with corresponding yellow incisures. About half of the rim of the alulae brownish; halteres paler.

Type and allotype: Sheep Creek Canyon, near Phelan, California, 24 May, 1945. *Paratypes:* Eleven males and six females taken with the types; three males from Pala, California, 6 June, 1945; one male and three females, Mountain Home Canyon in the San Bernardino Mountains, California, 9 May, 1946. *Trifidus*, Latin, cleft into three parts, i.e., the cinereous color pattern of the thorax.

THE EFFECT OF DDT ON THE METABOLISM OF THE JAPANESE BEETLE, POPILLIA JAPONICA NEWMAN[1]

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DDT is extremely toxic to certain insects, but precise information concerning its mode of action is lacking. Histological studies have failed to show any significant morphological changes following exposure. Hence, it is likely that the insecticide acts on metabolic processes of the insect, producing modifications which eventually lead to its death. To determine whether such modifications occur, normal insects and others poisoned with various concentrations of DDT were compared with respect to weight, rate of desiccation over anhydrous $CaCl_2$, and the content of water, glycogen, glucose, fat, and protein. This information may assist in understanding the action of the compound and may eventually lead to the production of more effective insecticides and methods of insect control.

The Japanese beetle was selected for this study because it is easily reared in the laboratory, its larvae may be obtained in the vicinity of New York City in considerable numbers from August to June, and the adults are very abundant during July and August. Furthermore, a considerable amount of work has already been published on the physiology of this insect. In the present experiments, the egg, the third-instar larva, pupa, and adult stages were used. They were maintained at a temperature of 25° C. throughout the experiment. Highly purified (standard) DDT, melting point 108.6 to 109.5° C., dissolved in peanut oil was used. Since the experimental procedure differed for each stage of the life cycle, an account of the method will be given in each section of the paper.

EFFECT OF DDT ON THE EGG

Groups of approximately 100 eggs, on successive days of embryonic development, were exposed by placing them for a 10 minute period in a petri dish on the surface of filter paper moistened with a 5% or a 10% solution of DDT. The eggs were rolled on the paper so that the entire surface was moistened with the solution. To serve as controls, comparable series of eggs were exposed in a similar manner to peanut oil without DDT. Before and after exposure, the eggs were kept on the surface of moist soil in 1-ounce metal salve boxes. Observations were made on the number of larvae which formed within the egg, on the number which hatched, and on the duration of the egg stage. The results, given in Table I, show a relatively high mortality when newly laid eggs were exposed to peanut oil or to DDT solutions, probably caused by heavy growths of molds. DDT had no effect on embryonic

[1]The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and New York University.

development. However, it did result in a slight retardation of hatching when the eggs were exposed early in development. Embryogeny was completed in the normal period of time, as evidenced by the appearance of the larval jaws and the outline of the body which are visible through the chorion, but the larvae had difficulty in breaking through the chorion and thus hatching was delayed. No corresponding delay in hatching was noted in the peanut oil series. The larvae which emerged from the eggs exposed to DDT showed characteristic tremors, probably caused by contact with the poison after hatching.

TABLE I

EFFECT OF DDT ON EMBRYONIC DEVELOPMENT

Age of Eggs (days)	Peanut Oil Controls				5% DDT				10% DDT			
	No. of eggs	% hatched	% developed	Duration of egg stage (days)	No. of eggs	% hatched	% developed	Duration of egg stage (days)	No. of eggs	% hatched	% developed	Duration of egg stage (days)
Newly laid	150	78.0	80.0	12.5	98	80.5	81.6	12.7	101	64.3	67.3	13.3
1	100	93.0	93.0	12.2	102	84.3	88.2	13.2	110	87.3	92.7	13.5
2	100	87.0	87.0	12.4	100	91.0	93.0	14.0	135	88.1	96.3	13.7
3	150	93.3	95.3	12.3	112	92.8	95.5	13.3	111	92.8	99.1	14.2
4	100	95.0	96.0	12.4	108	90.7	92.6	12.9	94	89.3	92.5	12.9
5	100	97.0	97.0	12.1	106	94.3	99.0	12.5	112	92.8	99.1	13.0
6	102	95.1	96.1	12.1	109	96.3	96.3	12.1	112	94.6	97.3	12.4
7	100	98.0	98.0	12.0	100	93.0	97.0	12.2	112	96.3	99.1	12.6
8	100	98.0	98.0	12.1	112	94.6	95.5	12.0	95	91.6	96.8	12.1
9	105	100.0	100.0	12.1	100	99.0	100.0	12.0	96	100.0	100.0	12.1
10	101	97.1	97.1	11.9	99	97.0	97.0	12.2	94	99.0	99.0	11.9

EFFECT OF DDT ON THE LARVA

Weight and water content.—Larvae were poisoned by placing them for a 10 minute period in a petri dish on the surface of filter paper moistened with the desired concentration of DDT. They were weighed on a chainomatic balance, exposed to DDT, the excess oil blotted off with filter paper, and then placed in individual 1-ounce metal salve boxes containing moist soil. Weight readings were made at least once daily until death, when the larvae were completely desiccated by keeping them in an oven at 65° to 75° C. until constant weight readings were obtained. Water content was calculated from weight readings made before and after complete desiccation. Normal water content was determined by completely desiccating a number of normal larvae of each series to serve as controls for the poisoned ones. Desiccation procedures were of two types: (1) individuals were kept in a drying oven until their weights were constant; and (2) individuals were desiccated over anhydrous $CaCl_2$ until constant weights were obtained. The two methods produced identical results.

Exposure to a 1% solution of DDT resulted in the poisoning of only 6 of the 21 larvae used. Twelve of the remaining individuals went through a normal metamorphosis. The average weight of this series

during the two weeks immediately following exposure (figure 1) fluctuated between 88% and 100% of its original value. Exposure to 5% or 10% DDT resulted in the death of all of the larvae. The graphs in figure 1 show that in these series a very rapid loss of weight occurred during the first 4 days following exposure, after which the weight remained almost constant for several days. Those larvae which sur-

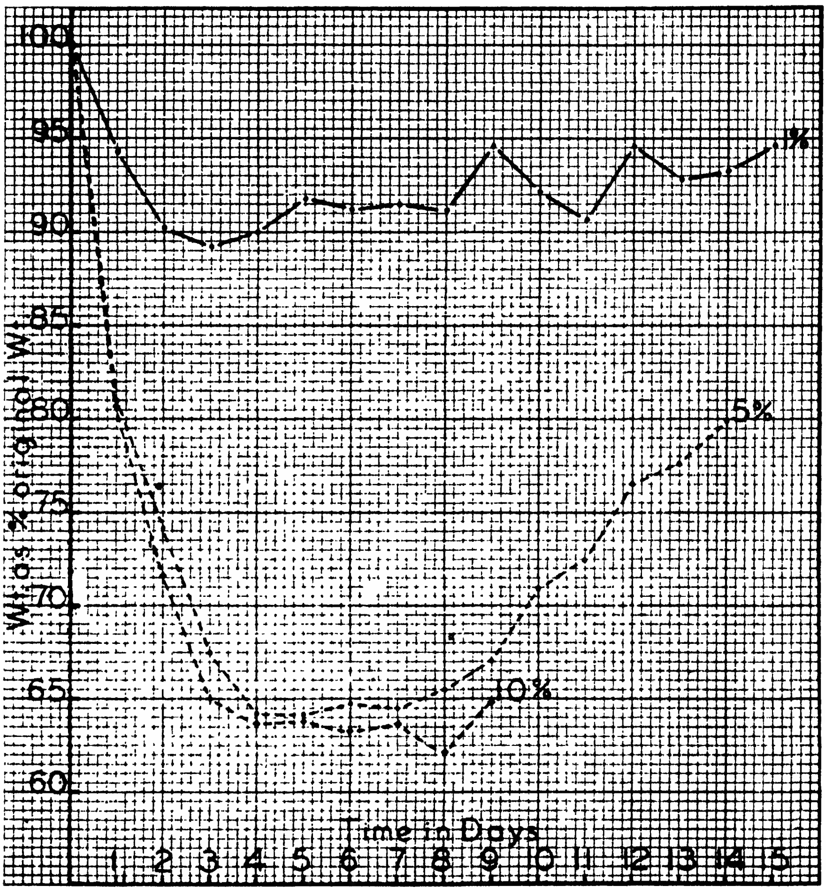

FIGURE 1. Rate of weight loss of third instar larvae after exposure to DDT solutions. Numbers indicate the concentration of DDT used.

vived longer than 7 or 8 days showed a gradual increase in weight until death occurred.

The rapid loss of weight following exposure to DDT suggested that poisoning affects the water balance of the individual. To test this hypothesis, normal larvae, larvae exposed to peanut oil, and others poisoned with 5% and with 10% DDT were placed in desiccators over

anhydrous $CaCl_2$ and weight readings were made daily until constant weights were obtained. Each series consisted of 25 larvae. The changes in weight are shown in figure 2. Normal individuals and those exposed to peanut oil without DDT lost weight at a slower rate than poisoned ones. No significant differences in the rates of weight loss were evident in those poisoned with 5% or 10% DDT. The poison

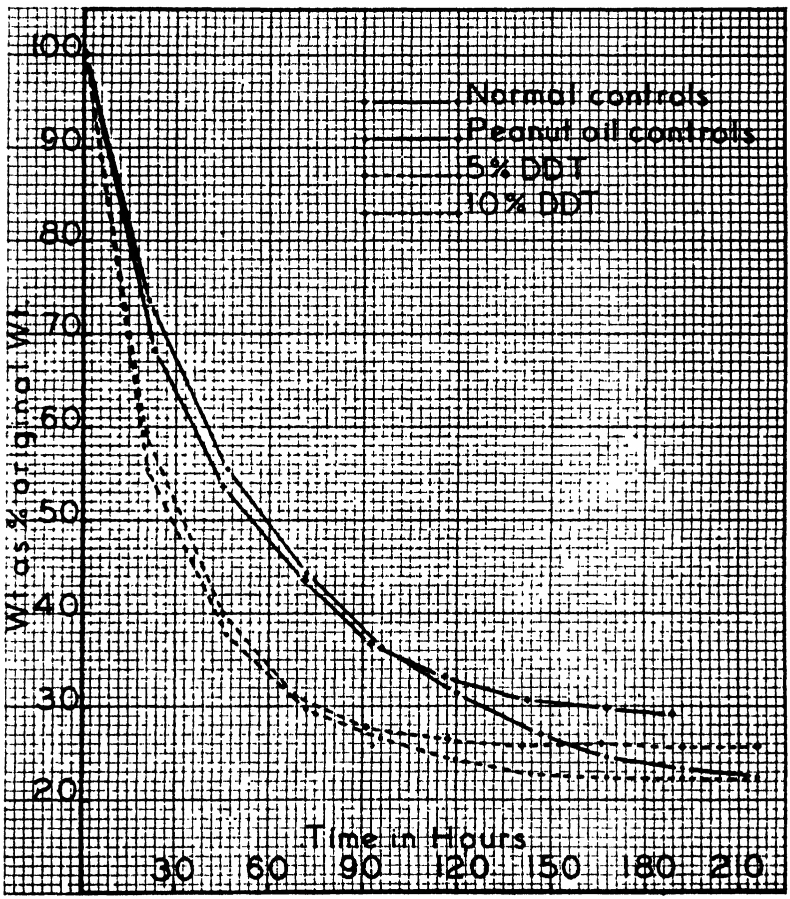

FIGURE 2. Rate of weight loss over anhydrous $CaCl_2$ of normal and poisoned third instar larvae.

appears to interfere with the ability of the larva to resist desiccation. Its effect might result from the greater activity of the poisoned larva, with the increased production and loss of metabolic water.

Table II contains a summary of the weight and water content changes of the larva following DDT poisoning. These data indicate that poisoned larvae lose about one-third of their weight before death

without a reduction in the relative amount of water which they contain. To determine whether their high water content may have been the result of the reabsorption of water from the moist soil during the latter part of the survival period, 20 larvae were exposed to 5% DDT and their water content determined after 4 days. In this series, the average weight loss was 56.5 milligrams, and the water content was 74.0% as compared with a water content of 72.8% for normal larvae of this group. Since the maximum weight loss occurred during the first 4 days following poisoning and since larvae maintained their normal percentage of water during this period, the weight loss must be due to the loss of other constituents as well as of water.

TABLE II

EFFECT OF DDT ON THE WEIGHT AND WATER CONTENT OF THE JAPANESE BEETLE

Stage	No. of beetles	Conc. of DDT (%)	Original weight (mg.)	Weight loss (mg.)	Time of survival (days)	Water content at death (%)	Normal Number used	Beetles water content (%)
Larva......	43	10	196.4	67.6	5.3	79.0 ± 0.40	45	77.6 ± 0.33
"	15	10	238.4	86.8	7.4	73.7 ± 0.85	65	72.2 ± 0.23
"	21	5	224.5	62.5	7.9	79.4 ± 0.72	45	77.6 ± 0.33
Pupa........	23	10	175.7	0.4	Pupa	metamorphosed		
"	10	5	177.8	0.3	"	"		
Adult.......	49	5	99.4	11.9	2.0	62.8 ± 0.32	89	67.8 ± 0.21
"	27	1	95.0	12.9	2.2	62.1 ± 0.23	"	" "
"	25	0.50	98.9	13.1	2.5	63.4 ± 0.34	"	" "
"	23	0.33	105.3	10.4	2.4	63.4 ± 0.28	"	" "
"	25	0.20	110.9	15.5	3.8	64.1 ± 0.36	"	" "
"	25	0.17	100.5	21.1	7.9	64.7 ± 0.36	"	" "
"	25	0.13	99.6	19.3	7.9	65.6 ± 0.31	"	" "
"	25	0.10	100.0	15.5	7.4	65.6 ± 0.40	"	" "
"	25	controls (not fed)	100.4	17.2	8.0	65.4 ± 0.35	"	" "

Biochemical changes.[2]—The above observations led to a study of the composition of normal and poisoned individuals to determine what constituents are lost. In these experiments 25 larvae were used in each series. Determinations of fat were made by the ether extraction of dried larvae in a soxhlet apparatus. The larvae were weighed, dried to a constant weight, pulverized with specially purified sand (see Bloor, 1929, p. 282) and transferred to the soxhlet apparatus. Extractions were continued until no additional residue was obtained when the ether was allowed to evaporate. Determinations of glycogen were made according to the method of Good, Kramer, and Somogyi (1933) as modified by Steel (1937). Glucose was determined by the Hagedorn and Jensen technique (Hawk and Bergeim, 1931, p. 435). Protein determinations consisted first in determining the total nitrogen by the

[2]The writer is indebted to Professor K. Brunings, Department of Chemistry, New York University, for suggestions regarding the biochemical procedures used in this paper.

micro-Kjeldahl procedure (Niederl and Niederl, 1938, pp. 51–59) as modified by Wagner (1940), and multiplying the nitrogen value by the protein conversion factor, 6.25.

Soon after exposure to DDT the larva becomes very active and eliminates a considerable quantity of fecal material. The amount of this material was determined by poisoning 25 larvae by a brief contact with a 10% solution and then placing them in covered petri dishes on the surface of weighed filter paper. At the end of 5 hours the filter paper was again weighed and the increase in weight was assumed to be the weight of the feces.

TABLE III

Composition of Normal Larvae and of Others Killed by Contact with 10% DDT, with an Analysis of the Weight Lost by Poisoned Larvae

	Normal Larva		Larva Killed with DDT Readings at Time of Death		Amount Lost Weight (mg.)
	Per Cent	Weight (mg.)	Per Cent	Weight (mg.)	
		196.4		128.8	67.6
Water	77.63 ± 0.33	152.47	79.02 ± 0.40	101.79	50.68
Fat	3.91 ± 0.15	7.68	4.01 ± 0.17	5.16	2.52
Glycogen	0.63 ± 0.052	1.24	0.14 ± 0.018	0.18	1.06
Glucose	0.53 ± 0.011	1.04	0.48 ± 0.023	0.62	0.42
Protein	9.70 ± 0.18	19.05	14.56 ± 0.34	18.75	
*Feces	7.40 ± 0.31	14.53			14.53
Total	99.8		98.2		69.21

* Determined by weighing the material eliminated by 25 larvae during the 5-hour period following exposure to DDT.

A summary of the analysis of normal larvae and of others within a few hours after death from DDT poisoning is shown in Table III. The percentage values for water, fat, and glucose are not statistically different for normal and poisoned larvae. However, since the weight of the larva killed by DDT is only about two-thirds of its original value, the weights of these compounds are significantly lower in the poisoned than in the normal individuals. The glycogen content of the larva killed with DDT is almost depleted and the per cent of protein has increased. There is no change in the amount of protein since its weight in normal larvae is not statistically different from that in poisoned ones at the time of death. The weight lost as a result of DDT poisoning is due to a reduction in the amount of water, feces, fat, glycogen, and glucose. The fat, glycogen, and glucose are the compounds which furnish energy for muscular activity and their loss is associated with the violent muscular tremors which accompany DDT poisoning.

Respiratory metabolism.—Respiratory readings were made on larvae poisoned with 10% DDT using the modified Krogh manometer (Bodine and Orr, 1925). All readings were made at a constant temperature of 25° C. Thirty-seven individuals were poisoned but only 5 of them survived beyond the sixth day after exposure. The graphs (figure 3)

were constructed from the averages of the larvae which survived on each day of the experiment. Since the weight of the larva decreased rapidly following exposure, the values are expressed as cu. mm. O_2 per larva as well as per gram body weight. DDT poisoning results in an increase in O_2 consumption which becomes evident about 2 hours after

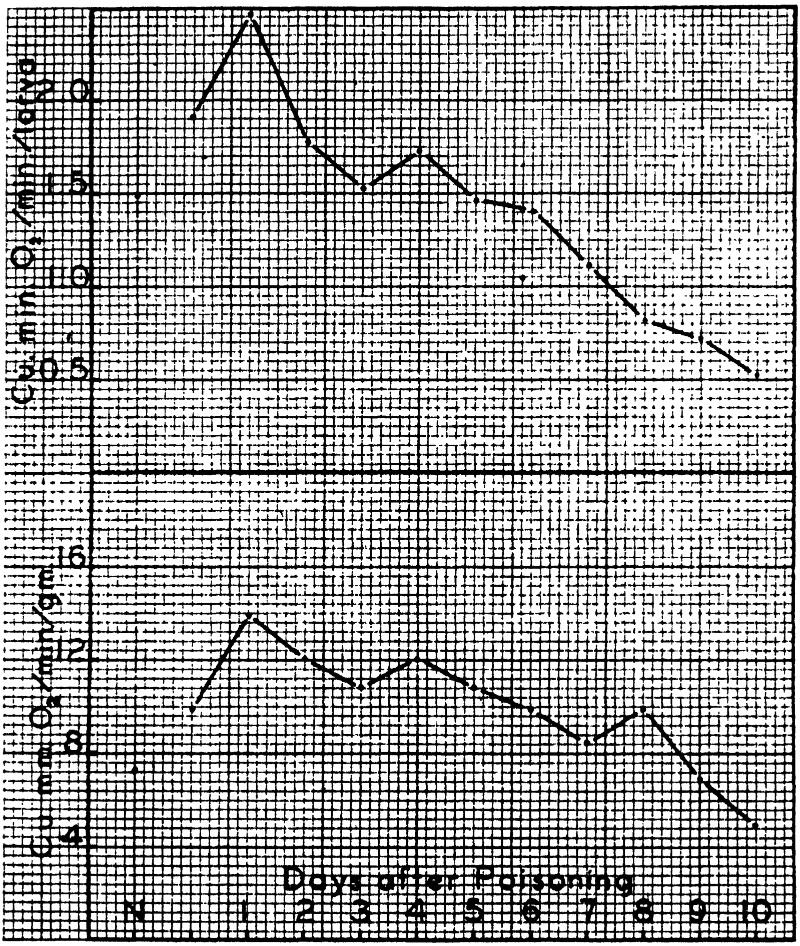

FIGURE 3. Rate of oxygen consumption of third instar larvae following exposure to 10% DDT. N, indicates the rate of normal larvae.

exposure. The rate continues above normal for about 5 days, after which it declines until the larva dies. The period of increased O_2 consumption corresponds with that during which the larva is undergoing characteristic tremors and the increase in metabolism is probably caused by increased activity. The respiratory quotients varied between 0.7

and 0.8 during the first 2 days, after which they dropped to values ranging between 0.6 and 0.7.

EFFECT OF DDT ON THE PUPA

Pupae were exposed by placing them for a 10 minute period in a petri dish on the surface of filter paper moistened with 5% or 10% DDT

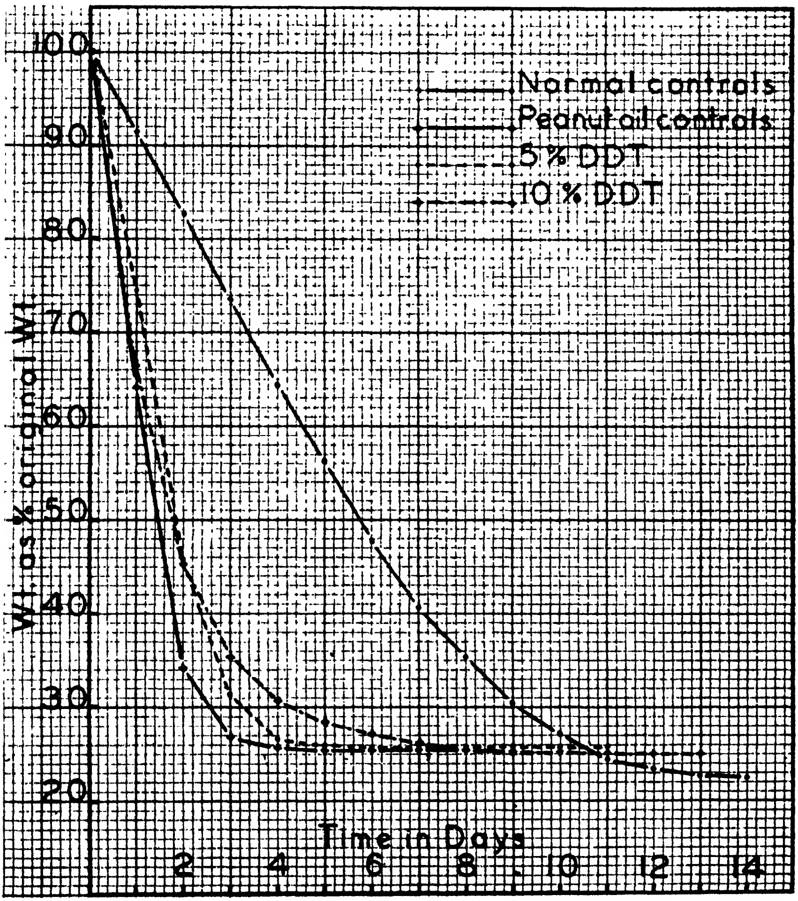

FIGURE 4. Rate of weight loss over anhydrous $CaCl_2$ of normal pupae, and of others exposed to DDT or to peanut oil.

solutions. After exposure they were placed on the surface of moist soil in individual 1-ounce metal salve boxes. Daily weight readings were made until emergence or until death. Both early and late pupae were used in these experiments. No definite signs of poisoning were noted in the exposed pupae. Weight readings were normal throughout

pupal development (Table II) and there were no characteristic muscle tremors, although the normal pupa is relatively active. Of 10 pupae exposed to a 5% solution, 9 produced adults. Some of them showed tremors, probably due to contact with the poison during or after eclosion. Of 23 pupae exposed to a 10% solution, 17 produced adults all of which showed signs of poisoning. In four cases abnormal emergence resulted. The abdomen remained large as in the pupa,

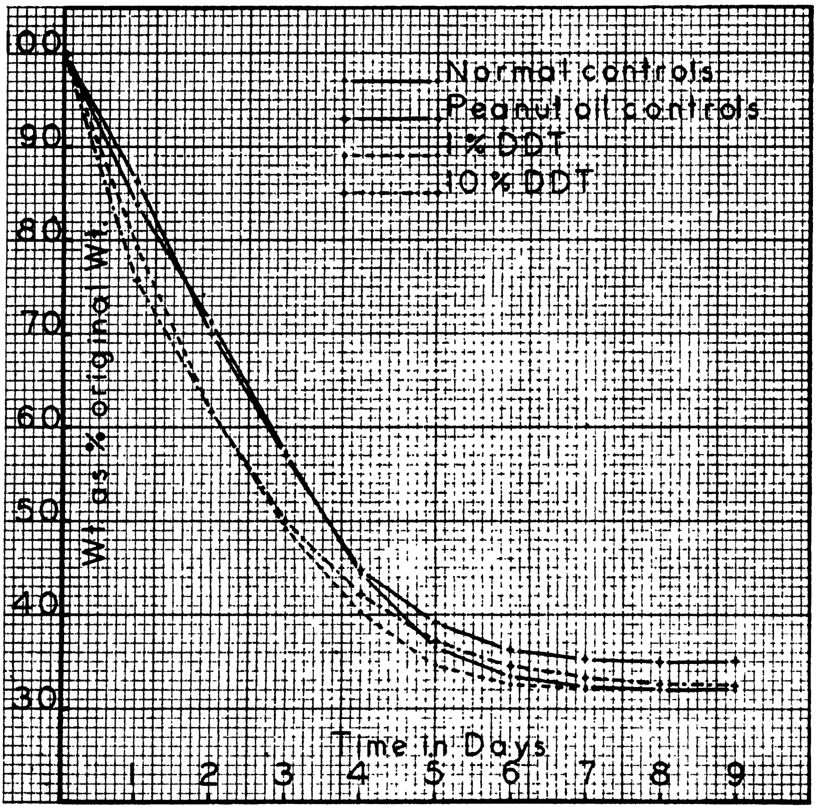

FIGURE 5. Rate of weight loss over anhydrous $CaCl_2$ of normal and poisoned adults.

portions of the pupal skin remained attached to the abdomen and the wings, and the adults were unable to spread their wings. This abnormal emergence may indicate a penetration of the DDT into the pupa although no signs of poisoning were visible until the time of emergence.

Groups of 25 pupae were exposed to 5% DDT, 10% DDT, and peanut oil without DDT and desiccated over anhydrous $CaCl_2$ to compare their rates of weight loss with those of a comparable series of normal pupae. The results (figure 4) show that pupae exposed to

peanut oil lost weight as rapidly as those exposed to 5% or 10% DDT solutions and at a much faster rate than did normal pupae. Hence, the greater rate of desiccation of the exposed pupae appears to be associated with some physical action of the oil on the water permeability of the cuticle. The oil might bring about this effect by dissolving a waxy covering from the surface of the pupa.

EFFECT OF DDT ON THE ADULT

Weight and water content.—Adult beetles were poisoned with DDT according to the procedure outlined above for larvae and pupae and also

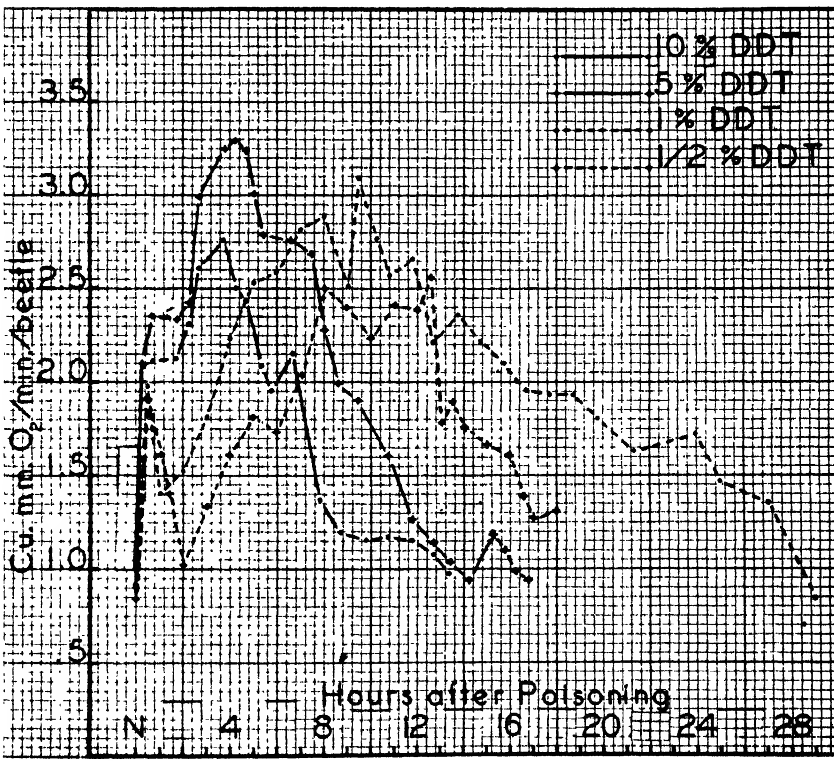

FIGURE 6. Rate of oxygen consumption of adults following exposure to different concentrations of DDT. N, indicates the rate of normal adults.

by placing a small drop of a peanut oil solution on the front of the head. Their subsequent treatment was the same as that described for the larvae. Changes in weight and water content are summarized in Table II. The table shows that under the conditions of the experiment, DDT is toxic to adult beetles in concentrations as low as 0.2%. At lower concentrations, the insects probably died of starvation. Since the

normal water content of adults averages 67.8% there is a slight but significant loss of water in the control series (normal adults kept in moist soil but without food) and in those subjected to sublethal concentrations of DDT. However, the water loss is slightly greater in those which died of poisoning. In the table, differences in the average water content of adults as small as 1.5 % are statistically significant. Hence, adults exposed to concentrations of 0.33 %or greater have a reduced water content as compared with the control series. The loss of water is sufficient to account for nearly all of the weight lost by the poisoned individuals.

Groups of 25 adult beetles exposed to 1% DDT, 10% DDT, and peanut oil without DDT were desiccated over anhydrous $CaCl_2$ and their rates of weight loss compared with that of a comparable series of normal adults. The results are plotted in figure 5. Normal adults and those exposed to peanut oil without DDT lost weight at a slower rate than poisoned individuals. No significant differences were noted between those poisoned with 1% and 10% DDT. This greater rate of weight loss in poisoned adults, as in the case of the larvae, may be associated with their greater muscular activity.

Respiratory metabolism.—Readings were made on the rate of O_2 consumption of adult beetles poisoned with various concentrations of DDT. All readings were made at 25° C. The results are shown graphically in figure 6. Those poisoned with 5% or 10% DDT showed an immediate increase in O_2 consumption, the rate at the end of 15 minutes being more than twice the normal value. Two hours after exposure the rate again increased reaching a maximal value at the end of 4 hours. There was then a rapid decrease which continued for 9 hours after exposure to 10% and for 12 hours after exposure to 5% DDT. The oxygen consumption of adults poisoned with 1% or 0.5% increased rapidly and at the end of 30 minutes was about twice the normal value. There was then a marked decrease in rate until 2 hours after exposure when it again increased, reaching a maximal value in 10 hours with a 1% solution and in 13 hours with a 0.5 % solution. The maximal values averaged between 3 and 4 times the normal rate regardless of the concentration of DDT used. Oxygen consumption readings were also made on adults poisoned with 0.2% DDT. In this series, there was no marked increase in rate, the values rising to a point slightly above normal and remaining there for a period of 2 days. An attempt was made to correlate the increase in respiratory metabolism with the presence of DDT tremors. It was noted that those insects which showed violent tremors also used oxygen very rapidly, while those which showed only slight muscular activity used oxygen slowly. The increase in metabolic rate of the poisoned insect appears to be the result of its increased activity.

DISCUSSION

The differences in susceptibility manifested by the various stages in the life cycle are difficult to explain. The egg and pupa show no signs of poisoning even when exposed to a 10% solution of DDT. There is some evidence that the poison is able to penetrate the chorion of the

egg and the cuticle of the pupa, since hatching was delayed when exposure occurred early in embryonic development and many adults showed imperfect emergence after exposure of the pupae. It was found that most larvae survived a 10 minute exposure to a 1% solution and went through a normal metamorphosis, whereas adults were killed by a brief contact with 0.2% solution. This difference in susceptibility may be correlated with the relative amount of active tissue in the larva and adult. The third-instar larva weighs approximately 200 milligrams and possess a relatively small amount of exoskeleton; whereas, the adult weighs only about 100 milligrams and has a very thick, heavily sclerotized, exoskeleton.

When poisoned, the larvae and adults manifest certain differences which may be correlated with physiological differences between the two stages. The poisoned larva maintains its normal water content although it loses approximately one-third of its original weight before it dies. The adult loses approximately one-tenth of its original weight before death and this loss is accompanied by a reduction in water content. In both stages this weight loss occurs while the insect is in a moist environment and in contact with moist soil. The adult evidently requires the ingestion of succulent food in order to maintain its normal water content, since normal unfed adults lost significant amounts of water when kept in salve boxes in contact with moist soil (Table II). On the other hand, the starved larva is able to absorb water from moist soil and regain its normal water content after suffering partial desiccation in a relatively dry environment. One important difference between the two stages is associated with the elimination of a considerable quantity of feces by the poisoned larvae whereas very little fecal material is eliminated by poisoned adults. The gut of the larva normally contains a large amount of soil. This soil is entirely eliminated by the normal insect at the beginning of metamorphosis, and most of it by the poisoned larva soon after exposure to DDT. Furthermore, larvae survived an average of 5 to 8 days after exposure, while most adults died within 2 or 3 days. During this time the larva uses practically all of its glycogen and some of its fat and glucose. Respiratory quotient readings on poisoned larvae indicate that carbohydrates and fats are oxidized during the first 2 days after exposure, following which the fat reserve is utilized. The only comparable experiments made on the adult were of total fat content. The normal adult was found to have $2.64 \pm 0.09\%$; and the adult which had died of DDT poisoning, $3.35 \pm 0.11\%$ fat. Since poisoned adult beetles lose weight and water following exposure, the amount of fat remains practically unchanged. It seems likely that the only food used by the adult during tremors is of a carbohydrate nature.

The rate of oxygen consumption following exposure to DDT increased to nearly 2 times its normal value within 24 hours in the larva, and to 3 or 4 times the normal value within several hours in the adult (figures 3 and 6). The increased oxygen uptake in both cases is correlated with increased muscular activity and is present only as long as the insect shows characteristic DDT tremors. These results are in agreement with those of Barron (1945) who found that the oxygen uptake of the meal worm beetle, *Tenebrio molitor*, increased about 3 to 5 fold following

a one and one-half hour exposure to a film of solid DDT. Barron believes that the increased oxygen uptake is caused by increased activity since both muscle tremors and increased oxygen consumption were eliminated by the use of narcotics. Further evidence that increased activity is the cause of the acceleration in the rate of oxygen utilization is found in the observation by Barron that the respiration of grasshopper eggs in diapause is not affected by exposure to DDT in 70% alcohol, and the eggs within 2 days of hatching showed a slight inhibition of respiration after DDT treatment.

The observation that the glycogen supply of the larva poisoned with DDT was almost depleted at the time of death is in agreement with the results obtained by other workers following the administration of DDT to mammals. Lauger, Pulver, and Montigel (1945) were the first to demonstrate the depletion of liver glycogen following DDT ingestion. Their work was verified by Barron (1945) who showed that in rats, sacrificed 3 to 5 hours after the ingestion of DDT and while having strong muscle tremors, the blood sugar and liver glycogen were reduced, and the blood lactic acid increased. In rats treated with DDT, but kept quiet by the injection of nembutal, these compounds were present in normal amounts. Thus the reduction in the glycogen supply of the poisoned animal appears to be the result of increased muscular activity.

The metabolic changes following exposure to DDT (such as increased activity, increased oxygen utilization, loss of glycogen, glucose and fat) suggest the possibility that, in the Japanese beetle larva, death may be the result of a depletion of the readily available energy supply. The increased muscular activity is induced in some manner by the action of DDT. It results in a rapid utilization of the carbohydrate reserve, after which the insect dies. Evidence that starvation is a factor in the death of this insect following exposure to DDT may be obtained from the fact that the stage which is able to survive a relatively long period of starvation is also able to survive a relatively long time following DDT poisoning. The unfed Japanese beetle larva survives an average of 30 days (Ludwig and Landsman, 1937), whereas the unfed adult can live only 8 days (Table II). When poisoned, the larva survives an average of 5 to 8 days and the adult dies in 2 to 3 days. The observation that the protein content of the larva remains unchanged following DDT poisoning does not invalidate this hypothesis, since Wigglesworth (1939) pointed out that "in some insects there appears to be no utilization of proteins at all during fasting."

SUMMARY

1. Different stages in the life cycle of the Japanese beetle vary greatly in their susceptibility to DDT. Embryonic development is not affected, but when the eggs are exposed early in development, hatching is delayed. Exposed pupae show no characteristic signs of poisoning, but in some cases, an abnormal emergence from treated pupae occurs. The larvae are killed by contact with 5% or 10% solutions and the adults by contact with 0.2% solutions in peanut oil. This difference in susceptibility may be correlated with the relative amount of active tissue in the larva and adult.

2. Poisoned larvae maintain their normal per cent of water

although they lose approximately one-third of their original weight. The decreased weight is the result of a loss of water, feces, glycogen, glucose, and fat. No significant loss of protein occurs in DDT poisoned larvae. Poisoned adults lose approximately one-tenth of their original weight and this loss is accompanied by a reduction in water content.

3. Poisoned larvae and adults lose water over $CaCl_2$ at a greater rate than the corresponding stages of normal insects. DDT appears to affect the ability to withstand desiccation. Its action may be correlated with the increased activity of the poisoned insect with the resulting greater rate of production and loss of metabolic water. Pupae exposed to peanut oil without DDT or to DDT solutions in peanut oil lose weight over $CaCl_2$ at a greater rate than normal pupae. In this case, the greater loss of weight of the treated insects is believed to be associated with some physical action of the oil on the water permeability of the cuticle. The oil may bring about this effect by dissolving a waxy covering from the surface of the pupa.

4. DDT poisoning of the larva results in an increase in the rate of oxygen consumption which becomes evident about 2 hours after exposure and reaches a maximal value of 2 times the normal rate within 24 hours. The rate continues above normal for 5 days, after which it declines until the animal dies. Adults poisoned with DDT show an immediate increase in oxygen utilization, the rate reaching 2 times the normal value in 15 minutes with high concentrations, and in 30 minutes with low concentrations of DDT. The maximal value averages 3 to 4 times the normal rate regardless of concentration The increased oxygen consumption in both stages is correlated with increased muscular activity and is present only as long as the insect shows characteristic tremors.

5. The metabolic changes following a lethal exposure to DDT suggest that, in the Japanese beetle larva, the increased muscular activity associated with DDT poisoning results in a rapid utilization of the carbohydrate reserve after which the insect dies.

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THE EFFECTS OF THE WAR ON JAPANESE ENTOMOLOGICAL PUBLICATIONS

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There are nine continuous periodicals in Japan devoted entirely to papers on insects. Two of these are published exclusively in European languages, three contain papers in both Japanese and foreign languages, and the remaining four are in Japanese, with a few English or German resumés. The lack of paper and type forced the discontinuance of all nine of these periodicals by March of 1945. None had recommenced publication when the writer left Japan at the end of January, 1946. Entomologists and librarians in the United States may find it desirable to know exactly the last number of each periodical to appear. The nine journals follow in order of importance to entomology. The notation "(For.)" means that all papers are in European languages, principally German and English; "(Jap.)" indicates papers in Japanese characters; and "(For. & Jap.)" means some papers are in Japanese, others in foreign languages. For each periodical are given the volumes and years published, the date of enforced discontinuance, the publisher, and a note on the contents.

1) *Insecta Matsumurana* (For.), Vol. I–XVI (1926–1942).
Discontinued publication December, 1942.
Published by the Entomological Institute, Hokkaido Imperial University, Sapporo, Japan.
Principally taxonomic papers including all orders, by students and associates of Professor Matsumura.

2) *Kontyu* (For. and Jap.), Vol. I–XVI (1926–1944).
Discontinued August, 1944.
Published by the Entomological Society of Nippon, Tokyo, Japan.
Taxonomic papers on all orders.

3) *Mushi* (For. & Jap.), Vol. I–XV (1924–1943).
Discontinued January, 1943.
Published by the Fukuoka Entomological Society, the Entomological Laboratory, Kyushu Imperial University, Fukuoka, Japan.
Taxonomic papers on all orders.

4) *Transactions of the Kansai Entomological Society* (For. & Jap.), Vol. I–XIV, pt. 1 (1930–1944).
Discontinued February, 1944.
Published by the Kansai Entomological Society, Kotoen, near Kobe, Japan.
Taxonomic papers on all orders; written principally in Japanese. Formerly important; now much less so.

5) *Tenthredo, Acta Entomologica* (For.), Vol. I–IV (1936–1942).
Discontinued November, 1942.
Published by the Takeuchi Entomological Laboratory, Shinomiya, Yamashina, Kyoto, Japan.
Published and edited by Takeuchi, Japan's distinguished sawfly authority. Papers mostly on taxonomy of Lepidoptera and sawflies.

6) *Oyo-Kontyu* (Jap.), Vol. I–IV (1938–1943).
Discontinued October, 1943.
Published by the Nippon Society of Applied Entomology, Tokyo, Japan.
Japan's journal of applied entomology.

7) *Zephyrus* (Jap.), Vol. I–IX (1929–1943).
Discontinued October, 1943.
Published by the Entomological Laboratory, Kyushu Imperial University, Fukuoka, Japan.
A well-illustrated periodical entirely on Lepidoptera. Papers principally by Professor Esaki and his students. All papers in Japanese.

8) *Insect World* (Jap.), Vol. I–XLIX (1897–1945).
Discontinued March, 1945.
Published by the Nawa Entomological Laboratory, Gifu, Japan.
Japan's oldest entomological periodical. Printed on very inexpensive paper, with inferior illustrations, and of little international interest.

9) *Kontyu-Kai* (*Entomological World*) (Jap.), Vol. I–XI (1933–1943).
Discontinued December, 1943.
Published by the Insect Lovers' Association, Tokyo, Japan.
Now a minor journal entirely in Japanese and of very little systematic importance.

In December, 1945, vol. I, pt. 1 of the ***Transactions of the Nippon Lepidopterological Society*** was published by Y. Okada, Yanagidai-cho, Saga, Kyoto, Japan. How long-lived this new journal will be is uncertain. At any rate, it was the first entomological periodical to appear in Japan after the surrender by the Japanese.

The Entomological Institute of the Hokkaido Imperial University is making preparations to publish a new periodical, according to information received from Sapporo in April, 1946. The periodical will be entirely in Japanese and the proposed title is ***Matsumushi***. It will not include systematic papers, since these are already handled by ***Insecta Matsumurana***, and it will be a companion publication to the latter.

Important entomological papers have appeared in several publications on zoology and natural history. Papers on myriapods and Arachnoidea, groups included in entomological periodicals in America, are also found in these publications. The following are the six most important periodicals in this category:

1) *Transactions of the Sapporo Natural History Society* (For. & Jap.), Vol. I–XVIII (1906–1943).
   Last published in December, 1943.
   Published by the Sapporo Natural History Society, Hokkaido Imperial University, Sapporo, Japan.
2) *Transactions of the Natural History Society of Formosa* (For. & Jap.), Vol. I–XXXIV (1911–1944).
   Discontinued December, 1944.
   Published by the Natural History Society of Formosa, Taihoku Imperial University, Taihoku, Formosa.
3) *Bulletin of the Biogeographical Society of Japan* (For. & Jap.), Vol. I–XIII (1929–1943).
   Discontinued in October, 1943.
   Published by the Biogeographical Society of Japan, Tokyo.
4) *Annotationes Zoologicae Japonenses* (For.), Vol. I–XXII (No. 2?) (1897–1943).
   Discontinued in middle of 1943.
   Published by the Zoological Society of Japan, Zoological Institute, Faculty of Science, Tokyo Imperial University, Tokyo.
5) *Dobutsugaku-Zasshi* (*Zoological Magazine*) (Jap.), Vol. I–LVI, Pt. 6), (1888–1944).
   Discontinued June, 1944.
   Published by the Zoological Society of Japan, Zoological Institute, Faculty of Science, Tokyo Imperial University, Tokyo.
6) *Oyo-Dobutsugaku Zasshi* (*Journal of Applied Zoology*) (Jap.), Vol. I–XV (1929–1944).
   Discontinued July, 1944.
   Published by the Japanese Society for Applied Zoology, Zoological Institute, Faculty of Agriculture, Tokyo Imperial University, Tokyo.

There appears to be no immediate prospect for resumption of publication by any of the Japanese periodicals, particularly those in foreign languages. The few Japanese printers who still had type in Roman letters were swamped with work for American troops and type of any kind was scarce. Paper of a grade acceptable for scientific publications is still unobtainable. However, the barriers to resumption of publication are emphatically mechanical. Most Japanese entomologists, as well as other biologists, have manuscripts ready for the time when publishing is again possible. The papers and books awaiting publication contain many drawings and very beautiful colored plates.

NUTRITION OF ATTAGENUS (?) SP. II.
(Coleoptera: Dermestidae)

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In a preceding paper (Moore, 1943), I described a partly synthetic ration which supported slow growth of *Attagenus* larvae. Work on the nutrition of the yellow species (Moore and Moore, 1942) has been continued, the insects being handled approximately as already described. About 0.5 gm. of food and twenty newly-hatched larvae were placed in each 2-dram vial. The incubator temperature has been raised from 87° to 90° F. to accelerate growth and, in the more recent work, the humidity has been reduced to 55% to prevent deliquescence of certain amino acid mixtures and to minimize the growth of molds and other unwanted organisms.

The basic ration, described in the preceding paper, was simplified by omitting extracted fish meal, cystine, glucosamine HCl, urea, phytin, β-alanine, and p-aminobenzoic acid, none of which was found to produce consistent increases in growth. Vitamin Test Casein Smaco or Labco Purified Lactalbumin 7 HAAX have been used as sources of protein, usually reinforced with 1% tryptophane. Other lipids have replaced those used previously. All lipids were added shortly (one to two days) before each experiment was started.

FOLIC ACID AND BIOTIN

Since 28 June 43, Professor Roger J. Williams has kindly supplied me with his folic acid concentrates. These concentrates varied in potency from 3100 to 28000, (Mitchell and Snell, 1941). They were dissolved in a volume of aqueous alcohol such that one drop contained about one micogram of potency 40,000.

Biotin Smaco or Merck was used.

Rations had the following approximate compositions:

[1]Acknowledgments are due to Dr. J. C. Forbes and Dr. Herbert McKennis, Jr., of Richmond, Va., and to my father, Dr. J. Percy Moore, of Philadelphia, for suggestions as to the work and for criticism of the manuscript. For technical assistance, I am indebted to my wife, Marion B. Moore, and to Reba Stillman and Isobel C. McGlothlin.

TABLE I

	1	2	3
Lactalbumin 7 HAAX (Labco)	....	400 mg.	200 mg.
Vitamin Test Casein (Smaco)	350 mg.	....	....
dl Tryptophane	....	....	5
Corn starch (Argo)	150	100	300
Salts, USP #2	15	15	15
Glycerol	60	60	60
Choline chloride	1.0	0	1.0
Thiamine hydrochloride	0.020	0.020	0.020
Riboflavin	0.010	0.010	0.010
Nicotinic acid	0.080	0.080	0.080
Pantothenic acid	0.025	0.010	0.025
Pyridoxin	0.010	0.004	0.010
Folic acid π 40,000	0	0.001	0.001
Biotin	0	0.0008	0.0004
Inositol	0	0.040	0.040
p-Aminobenzoic acid	0	0.040	0.040
Desynon[2]	4 drops	4 drops	0
Vitamin E solution	1 drop	1 drop	0
Vitamin K solution	1 drop	1 drop	0

[2]Desynon (Winthrop Chemical Company). An alcoholic solution of purified vitamins A and D.

In experiment 259, ration 1 was enriched with folic acid, biotin, and pure, dried, debittered brewers yeast (Vita-Food Red Label). The results appear in Table II.

TABLE II

EFFECT OF ADDING FOLIC ACID AND BIOTIN OR YEAST TO RATION 1

Average weight per larva at four and seven weeks. Twenty newly-hatched larvae per tube. 86° F., 60% R. H. 27 Nov. 43 to 15 Jan. 44.

SUPPLEMENTS			WEIGHT PER LARVA milligrams	
FOLIC ACID micrograms	BIOTIN micrograms	YEAST milligrams	4 weeks	7 weeks
0	0	0	0.4 0.4	0.7 0.6
1	0	0	0.7 0.7	2.8 3.1
2	0	0	0.9 0.7	3.4 3.3
2	0.8	0	0.9 1.0	4.7 4.7
2	0	50	1.1 1.1	5.5 5.4

The results are typical. In a number of similar tests, folic acid always produced a marked increase in growth. A further increase at seven weeks always followed the addition of biotin. The addition of yeast commonly increased the growth rate over that obtainable with the known vitamins.

No reaction followed the addition of inositol, p-aminobenzoic acid, or hesperidine methyl chalcone (vitamin P)[3], separately or in combinations.

In experiments 279, 280, 281, and 282, various foods low in vitamins were enriched with mineral, liver fat 8 mg/gm, a solution of vitamins A, D, E, and K, and synthetic B vitamins including biotin, but omitting folic acid. The food substances used and the weight of larvae at seven weeks appear in Table III.

TABLE III

EFFECT OF ADDING FOLIC ACID TO VARIOUS LOW-VITAMIN FOODS, ALL OTHER KNOWN DEFICIENCIES BEING SUPPLIED

Forty newly-hatched larvae per test (2 tubes). 90° F., 60% R. H. 6 March to 24 April, 44.

FOOD	APPROX MG. PER TUBE									
Vitamin Test Casein (Smaco)	500		500		450		400		304	
l Tryptophane	5		5		5		5		....	
Glycerol CP	....		60		....		....		52	
Sucrose	....		....		50		....		....	
Starch cooked	....		....		....		100		....	
Starch, raw	....		....		....		....		131	
FOLIC ACID ADDED γ per tube	0	1	0	1	0	1	0	1	0	1
WEIGHT PER LARVA at 7 weeks, mg.	1.1	2.5	1.3	3.7	1.8	3.8	2.8	6.9	1.3	4.9
Lactalbumin 7 HAAX (Labco)	500		500		450		400		400	
Glycerol CP	....		60		....		....		60	
Sucrose	....		....		50		....		....	
Corn starch, cooked	....		....		....		100		100	
FOLIC ACID ADDED γ per tube	0	1	0	1	0	1	0	1	0	1
WEIGHT PER LARVA at 7 weeks, mg.	0.8	3.8	1.1	4.9	1.2	5.7	1.1	5.4	1.2	5.9

In experiments 318, 319, and 320, various low-vitamin foods were enriched with Desynon, vitamins E and K, mineral, and synthetic B vitamins, excepting biotin. Folic acid concentrate was added to furnish 2 micrograms/gram of the vitamin. Table IV shows the various proteins and carbohydrates used and the weight of the larvae with and without added biotin.

[3]Courtesy of Abbott Laboratories.

TABLE IV

EFFECT OF ADDING BIOTIN TO VARIOUS LOW-VITAMIN FOODS, ALL OTHER KNOWN DEFICIENCIES BEING SUPPLIED

Forty newly-hatched larvae per test (2 tubes). 90° F., 60% R. H. 12 June to 31 July, 44.

FOOD	APPROX. MG. PER TUBE									
Vitamin Test Casein (Smaco)	....		500		....		....		....	
Lactalbumin 7 HAAX (Labco)	171		....		500		380		....	
Raw egg white[4]	50		....		....		....		....	
dl Tryptophane	4		....		....		4		....	
Glycerol CP	....		100		100		100		....	
Corn starch (Argo)	258		....		....		100		....	
BIOTIN ADDED γ per tube	0	0.8	0	0.8	0	0.8	0	0.8	....	....
WEIGHT PER LARVA at 7 weeks, mg.	2.7	5.1	2.7	3.8	3.4	4.6	3.4	5.5	....	....
Lactalbumin 7 HAAX (Labco)	380		380		427		427		427	
dl Tryptophane	4		4		4		4		4	
Glycerol CP	100		100		100		100		100	
Corn starch (Argo)	100		....		....		....		....	
Soluble starch[5]	....		100		....		....		....	
Sucrose	....		....		50		....		....	
Glucose	....		....		....		50		....	
Galactose	....		....		....		....		50	
BIOTIN ADDED γ per tube	0	0.8	0	0.8	0	0.8	0	0.8	0	0.8
WEIGHT PER LARVA at 7 weeks, mg.	3.3	4.6	3.6	5.5	3.6	5.7	3.3	4.8	3.0	3.9

[4]Albumin, egg Impalp. Powder Soluble. J. T. Baker Chemical Co.
[5]Starch Soluble Powd. CP Baker analyzed.

Depletion experiments with folic acid have given erratic results. As a rule, the insects have continued to grow indefinitely, although significant mortality often occurred when the experiment was continued for over four months.

Omission of biotin only resulted in slower early growth. In experiment 344, egg albumin was substituted for milk protein and no biotin was added. The insects were still growing after sixteen weeks.

It seems probable that the depletion experiments were complicated by the presence of folic acid and biotin in the basic ration and by bacterial and fungal contamination. Methods of eliminating these difficulties are being studied.

CHOLINE

In experiment 325, using ration 2, choline was omitted. The results appear in Table V.

TABLE V

GROWTH OF *Attagenus* LARVAE WITH AND WITHOUT ADDED CHOLINE CHLORIDE

Number and average weight per larva. Twenty newly-hatched larvae per test. 90° F., 60% R. H. 27 June to 24 Oct., 44.

TUBE NO.	1		2		3	
CHOLINE CHLORIDE AT START, mg.......	0		0		0.4	
	No.	Av. Wt. mg.	No.	Av. Wt. mg.	No.	Av. Wt. mg.
4 weeks...........	17	0.14	17	0.14	20	0 65
7 weeks...........	15	0.25	15	0.21	20	3.55
CHLORINE CHLORIDE ADDED AT 7 WEEKS mg.	0		0.4		0	
9 weeks...........	15	0.28	15	0.53	20	6.25
11 weeks...........	14	0.34	15	1.2	20	7.8
13 weeks...........	12	0.43	15	2.6	....	....
15 weeks...........	11	0 54	15	4.0	....	....
17 weeks...........	10	0.68	15	4.6	....	....

TABLE VI

EFFECT OF ADDING LIPIDS TO RATION 3

Forty newly-hatched larvae per test (2 tubes). Mortality negligible. Weight per larva at four and nine weeks. 90° F., 55–60% R. H. 16 Oct. to 18 Dec., 44.

EXPERIMENT NO.	354	354	355	354	355	
TUBE NOS............	1–2	3–4	1–2	11–12	9–10	11–12
ADDED CHOLESTEROL mg.	0.08	0.10	1.0	....	1.0	....
LIVER FAT mg.	....	....	....	4	....	4
YEAST mg.	....	....	....	....	50	50
WEIGHT PER LARVA mg.						
at 4 weeks.......	0.5	0.6	0.6	0.8	0.8	1.0
at 9 weeks.......	5.1	6.0	5.9	6.1	7.5	7.1

Some gain in average weight occurred when choline was omitted, but the larvae probably obtained some choline as a result of cannibalism.

LIPIDS

The larvae failed to grow in rations like 1 or 3 unless a source of lipid was included. Coconut oil was inactive. Corn oil (saturated

with hydroquinone) or yeast supported growth for a time, but only lipids of animal origin supported continued growth. Petroleum ether extract of liver meal ("liver fat"), Desynon, Oil of Percomorpheum,[6] and cholesterol (Merck) were effective.

In experiments 354 and 355, various amounts of cholesterol, liver fat, and yeast were added to ration 3. Some of the results are summarized in Table VI.

TABLE VII

AMINO ACIDS OF FOUR RATIONS

Amino Acids		Ration No. 4	5	6	7
		mg./gm.			
dl	α—Alanine Pfanstiehl	....	8	2	....
	β—Alanine Smaco	....	4	2	....
l (+)	Arginine HCl Merck	4.86	16	8	10
dl	Aspartic acid Merck	....	8	2	....
l (—)	Cystine Smaco	....	8	4	....
l (+)	Glutamic acid Smaco	....	16	100	....
	Glycine Smaco	....	8	4	....
l (+)	Histidine HCl Merck	9.88	16	8	10
l (—)	Hydroxyproline Merck	....	8	4	....
dl	Isoleucine Merck	20.00	32	16	20
l (—)	Leucine Merck	18.00	32	16	20
l (+)	Lysine HCl Merck	25.00	32	16	20
dl	Methionine Merck	12.00	16	8	10
dl	Norleucine Merck	....	8	4	....
dl	Phenylalanine Merck	14.00	16	16	20
l (—)	Proline Merck	....	16	40	....
dl	Threonine Merck or Smaco	24.00	28	16	20
dl or l (—)	Tryptophane Merck or Smaco	4.00	8	4	10
l	Tyrosine Eastman	....	8	4	....
dl	Valine Merck	28.00	32	16	20
		159.74	320	290	160

In experiment 345, 22 Aug. 44, eighty newly-hatched larvae were given ration 3, plus 0.5 mg/gm of Merck's cholesterol. 1 Aug. 45, 839 F_1 larvae were recovered from the culture.

Cholesterol seems to be essential to the growth of the *Attagenus* larvae.

AMINO ACIDS

Ten amino acids are necessary for normal growth of rats. If arginine is omitted, rats grow slowly on the remaining nine. A composition (No. 4, Table VII) used in rat experiments (Kinsey and Grant,

[6]Mead Johnson & Co.

1944) was used as a starting point. To the ten essential amino acids, ten others were added. The twenty amino acids were mixed with water, sodium carbonate sufficient to neutralize the hydrochlorides present (Grau and Almquist, 1944), and mineral. Raw corn starch (Argo) was mixed with the partly dissolved amino acids, the mixture dried at 60°C. and powdered. Soluble starch, the B vitamins of ration 3, and liver fat were added one to two days before starting an experiment. The incubator was set at 90°F. and 55±2% R.H. Table VII gives the amino acids used in four mixtures.

Growth was slow in the first mixture prepared. Improved compositions were developed by adding separately one to two per cent of each of the twenty amino acids. In the first trial, arginine was found to be limiting. A new formula containing more arginine was prepared, tested as before, and phenylalanine found to be limiting. As some amino acids were increased in amount, others which seemed injurious or inert were reduced. Ration 5 is one of the improved formulae. Ration 6 gave the most rapid growth obtained to date.

TABLE VIII

EFFECT OF OMITTING ESSENTIAL AMINO ACIDS FROM RATION 5

Number and average weight of larvae surviving at seven weeks. Twenty newly-hatched larvae per test. 90° F., 55±2% R. H. 3 Apr. to 22 May, 45.

Amino Acid Omitted	Survivors at 7 Weeks	
	Number	Av. Wt.
Arginine	7	0.09
Histidine	3	0.07
Isoleucine	3	<0.04
Leucine	3	<0.04
Lysine	9	0.04
Methionine	4	0.05
Phenylalanine	4	0.05
Threonine	6	0.03
Tryptophane	5	0.04
Valine	5	0.04
None	20	0.40

In experiments 370 and 371, the amino acids were omitted one by one from ration 5. When the amino acids non-essential for rats were omitted, one at a time or all at once, growth continued for at least nine weeks. Table VIII gives the results of omitting the amino acids which are essential for rats.

Ration 7 is a mixture of the ten essential amino acids which I have been unable to improve by adding more of each or by changing the quantity of all. The results of six growth tests made with this mixture appear in Table IX.

TABLE IX

GROWTH AND SURVIVAL OF *Attagenus* LARVAE ON RATION 7

Twenty newly-hatched larvae per test. Number and average weight per larva of survivors. 90° F., 55±2% R. H.

EXPERIMENT	SURVIVORS			
	7 Weeks		9 Weeks	
	Number	Av. Wt. mg.	Number	Av. Wt. mg.
374	20	1.2	20	2.3
375	17	1.0	17	1.7
376	18	1.2	18	2.0
379	11	1.1	....	....
	19	1.1	....	....
380	18	1.1	16	2.2

In experiment 379, the amino acids of ration 7 were omitted one by one. Table X gives the results.

TABLE X

EFFECT OF OMITTING EACH AMINO ACID FROM RATION 7

Number and average weight per larva of survivors at seven weeks. Twenty newly-hatched larvae per test. 90° F., 55±2% R. H. 27 Aug. to 15 Oct., 45.

AMINO ACID OMITTED	SURVIVORS AT 7 WEEKS	
	Number	Av. Wt. mg.
Arginine	16	0.01
Histidine	9	0.04
Isoleucine	11	0.05
Leucine	3	<0.04
Lysine	9	0.04
Methionine	4	<0.03
Phenylalanine	4	<0.03
Threonine	10	0.02
Tryptophane	6	0.03
Valine	3	<0.04

The better mixtures containing twenty amino acids supported more rapid growth than ration 7. With ration 7, the highest average weight per insect at seven weeks was 1.2 mg. (6 tests). With ration 6, this value was 2.4 mg. (1 test).

CONCLUSIONS

Choline, arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophane, valine, and cholesterol may be added to the catalog of nutrilites essential for growth of the yellow species of *Attagenus*. Folic acid and biotin are at least essential for normal growth.

SUMMARY

Newly hatched larvae of *Attagenus* grew rapidly in mixtures of (1) purified milk albumin or casein 40–80%, (2) starch, (3) mineral, (4) animal lipids, (5) choline, (6) thiamine, (7) riboflavin, (8) nicotinic acid, (9) pyridoxin, (10) pantothenic acid, (11) folic acid, and (12) biotin. If 4, 5, 6, 7, 8, 9, or 10 was omitted, the insects failed to grow. When 11 was omitted, growth was much slower and mortality considerable. When 12 was omitted, growth was slower up to about eleven weeks. Using milk albumin (Labco Lactalbumin 7 HAAX) as the source of protein, Merck's cholesterol, 0.2 mg./gm., was an adequate source of added lipid. The addition of yeast usually resulted in more rapid growth.

Mixtures of twenty amino acids were substituted for protein by mixing with mineral, sodium carbonate to neutralize hydrochlorides, and water. The partly dissolved amino acids were mixed with raw starch, dried at 60° C., and powdered. The finished rations were prepared by diluting with soluble starch, adding B vitamins in aqueous alcohol, and liver fat at 8 mg./gm.

The ten amino acids essential for maximum growth of the rat were found to be essential for any growth of the *Attagenus* larvae. A mixture of the ten essential amino acids was developed which I was unable to improve. It contains about twice as much arginine as the rat requires. It supported less rapid growth than certain mixtures which contained ten additional amino acids.

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STUDIES ON THE CRANE-FLIES OF MEXICO

PART IX[1]

(Order Diptera, Superfamily Tipuloidea)

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The Tipulidae discussed in this report were received from Mr. Noel L. H. Krauss, collected in Morelos, chiefly in the vicinity of Cuernavaca, and from Dr. Alfons M. Dampf, collected by himself and by Mr. C. C. Plummer. I am very deeply indebted to these entomologists for allowing me to retain the types of the novelties in my personal series of these flies.

Tipula Linnaeus

Tipula (Trichotipula) kraussi sp. n.

Thorax almost uniformly polished reddish brown, abdomen entirely polished black; antennae elongate, bicolored; halteres and legs uniformly black; wings with a very strong blackish tinge; petiole of cell M_1 short to virtually lacking; male hypopygium with the posterior border of tergite very gently and broadly emarginate; inner dististyle broad.

Male.—Length about 10.5–11 mm.; wing, 11–12 mm.; antenna about 7 mm.

Frontal prolongation of head dark chestnut brown, polished; nasus elongate, black; palpi black. Antennae (male) elongate, more than one-half the wing; basal three segments obscure yellow, succeeding ones bicolored, the basal enlargement black, the stems abruptly yellow, the bicolored nature persisting to the terminal segment; basal enlargements oval, relatively abrupt; verticils shorter than the segments, the latter with a dense erect white pubescence. Head dark polished reddish chestnut; vertical tubercle very low.

Thorax almost uniformly polished reddish brown, the dorsopleural membrane darker brown; vestiture of the praescutal interspaces weak and sparse. Halteres black throughout. Legs with the coxae dark reddish, the posterior and middle pairs even more blackened, this color likewise involving the meral region; apex of middle coxae reddish; fore trochanter dark reddish, the remaining pairs even darker; remainder of legs uniformly blackened; claws (male) very small, simple. Wings with a very strong blackish tinge, the prearcular and costal fields even more saturated; cells *R*, *M*, *Cu* and *1st A* with paler central streaks and, in cases, the outer medial cells somewhat paler; stigma scarcely darker than the ground; obliterative areas before stigma and across base of cell *1st* M_2 very restricted; no post-stigmal brightening; veins brown, those of the outer medial field more delicate. No squamal setae but the

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[1]The preceding part under this general title appeared in these Annals (Vol. XXXIX, 119–139, 1946). Contribution from the Entomological Laboratory, Massachusetts State College.

margin distad of the squama with several setae of unusual length; outer veins of radial and medial fields with trichia. Venation: *Rs* about one-third to one-fourth longer than *m-cu;* R_{1+2} entire or with the extreme tip atrophied; petiole of cell M_1 very short to virtually lacking, not exceeding *m* in length; cell *2nd A* wide.

Abdomen, including hypopygium, polished black. Male hypopygium with the tergite transverse, the caudal margin very broadly and gently emarginate, at the midregion beneath with a rounded lobe; lateral lobes very low, with abundant short setae and a few longer ones. Outer dististyle a small dusky cylindrical lobe, with long black setae. Inner dististyle broad, the beak stout; lower beak more slender, separated from the beak by a broad notch; outer basal lobe small, triangular in outline. Appendage of ninth sternite appearing as an oval darkened lobe on either side, tipped with a few very long black setae. Aedeagus small; gonapophyses apparently lacking or reduced to microscopic rudiments. Eighth sternite narrowed posteriorly, the caudal border broadly pale and membranous, with dense elongate setae, the edge gently emarginate.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, August 3, 1944 (Krauss). *Paratopotype*, 1 ♂.

I am pleased to name this interesting fly for the collector, Mr. Noel L. H. Krauss, to whom I am indebted for several interesting Tipulidae from Mexico and Hawaii. It is entirely different from all other regional members of the genus, in its general appearance suggesting certain members of the subgenus *Microtipula* Alexander. I feel that the present reference to the subgenus *Trichotipula* Alexander is correct but the species must be held to be somewhat aberrant. It may be noted that in the Nearctic fauna there are several members of the subgenus that lack macrotrichia in the wing cells, as in the present fly. In its general appearance the species somewhat suggests members of the genus *Nephrotoma* Meigen.

Tipula (Trichotipula) vultuosa sp. n.

General coloration of body polished orange-yellow; anterior vertex with a darkened central line; femora yellow, the tips narrowly blackened, claws of male toothed; wings with a strong brownish yellow tinge, the veins dark and conspicuous; relatively numerous macrotrichia in cells R_3 to *2nd* M_2, inclusive, more abundant in the radial cells; intermediate abdominal tergites trilineate with black, the median stripe broad and conspicuous, the lateral pair narrower; male hypopygium with the outer dististyle narrow, approximately four times as long as broad across base; rostral prolongation of inner dististyle with abundant pale setae.

Male.—Length about 13 mm.; wing, 13 mm.; antennae about 4 mm.

Frontal prolongation of head relatively short, less than the remainder of head, yellow with a black line on either side; nasus slender; palpi with basal three segments brown, the terminal one more yellowed. Antenna (male) moderately long; scape and pedicel yellow, basal two flagellar segments obscure yellow, the succeeding ones weakly bicolored, the brown basal enlargements slightly darker than the more brownish

yellow stems; longest verticils exceeding the segments in length. Head orange-yellow, polished; anterior vertex broad, with a brown median stripe; vertical tubercle low and simple.

Pronotum orange-yellow. Mesonotum almost uniformly orange-yellow or fulvous, the surface polished, the lateral borders of praescutum restrictedly yellow; a very small brown marginal spot at the humeral region; setae of notum pale, sparse and inconspicuous. Pleura fulvous yellow, the dorsopleural region and pleurotergite paler. Halteres with stem obscure yellow, brighter at base, knob somewhat more darkened. Legs with the coxae fulvous yellow; trochanters testaceous yellow; femora yellow, the tips rather narrowly but conspicuously blackened, the amount subequal on all legs; tibiae obscure yellow, the tips narrowly darkened; tarsi black; claws (male) toothed. Wings with a strong brownish yellow tinge, the restricted prearcular field, costal border and outer radial field more infuscated; stigma scarcely differentiated from the ground; veins dark brown, conspicuous, those in the prearcular and costal fields more brownish yellow. Sparse macrotrichia in outer ends of cells R_3 to *2nd* M_2, inclusive, fewest in the last-named cell, much more numerous in the radial cells where they occupy more than the outer third of the cells; stigmal trichia very sparse, only two or three. Venation: *Rs* shorter than *m-cu* and about one-fourth longer than R_{2+3}; R_{1+2} preserved; petiole of cell M_1 short, a trifle longer than *m;* basal section of vein M_4 perpendicular, more than one-half as long as vein M_{3+4}; cell *2nd A* relatively broad.

Abdomen yellow, tergites two to six with a very conspicuous black central stripe or area, narrowly broken at the posterior margin, becoming more expanded on the outer segments; lateral borders of the same segments with narrower lines, the corresponding dorsal edge of the sternites less conspicuously blackened; remainder of abdomen, including hypopygium, yellow. Male hypopygium with the caudal margin of the ninth tergite with a deep V-shaped notch, the lobes obtuse, with the usual erect spinous setae, the retrorse group at the apex of lobe unusually numerous and having the same general appearance as the marginal series. Outer dististyle narrow, a little expanded on proximal half, at this point about one-fourth the length; setae long and numerous, reddish brown. Inner dististyle with the rostral portion elongate, about as long as the basal enlarged part of style, the apex suddenly narrowed; prolongation provided with abundant long pale delicate setae; setae of body of style back from the rostrum shorter and stouter, black; on posterior portion of style, in the region of the usual outer basal lobe, with a dense grouping of reddish bristles; what appears to represent the lower beak lies unusually basad, appearing as a blackened toothlike structure, with several setae on its basal half. Ninth sternite not produced. Eighth sternite with the pale membranous posterior margin gently convex in outline.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, September 5, 1944 (Krauss).

The most similar species include *Tipula* (*Trichotipula*) *aplecta* Alexander and *T.* (*T.*) *religiosa* Alexander, which have the hypopygial characters quite distinct, including the tergite, both dististyles, and the eighth sternite. Comparison with the species next described, *T.* (*T.*) *uxoria* sp. n., should be noted.

Tipula (Trichotipula) uxoria sp. n.

Allied to *vultuosa;* general coloration polished light castaneous, the praescutum variegated with darker, including very conspicuous blackened lateral spots in the humeral region and at the lateral ends of the transverse suture; fore femora with more than the outer half blackened; wings with a strong brownish yellow suffusion, cell *C* more infuscated; stigma short-oval, brown; restricted macrotrichia in outer ends of cells R_5 and M_1; abdomen orange, tergites with broken black areas on the intermediate segments.

Female.—Length about 9.5–11 mm.; wing, 11–12 mm.

Frontal prolongation of head polished yellow, narrowly darkened medially above, including the conspicuous nasus; palpi with first segment obscure brownish yellow, succeeding two segments a trifle darker; terminal segment obscure orange. Antennae with scape and pedicel light yellow; remainder of organ broken. Head with the vertical tubercle orange, high, conspicuously emarginate medially; posterior portion of vertex more infuscated, sending a darkened extension onto the vertical tubercle; occiput and genae somewhat paler.

Pronotum very pale yellow. Mesonotal praescutum polished light castaneous, variegated with darker, including four spots on the cephalic portion, representing the anterior ends of the usual four stripes; in addition, an even more conspicuous blackened spot in the humeral region at the margin, with a somewhat similar one at the end of the transverse suture; lateral praescutal border elsewhere more yellowed; remainder of notum similarly light castaneous or reddish orange, unpatterned. Pleura polished yellow, the dorsopleural membrane even paler. Halteres yellow. Legs with the coxae and trochanters yellow; fore femora yellow basally, with more than the outer half blackened; remaining femora yellow, the tips narrowly but conspicuously blackened; all tibiae obscure yellow, the tips narrowly blackened; tarsi black, the proximal ends of the basitarsi vaguely more brightened. Wings with a strong brownish yellow suffusion, cell *C* more infuscated, cell *Sc* light yellow; prearcular field brownish yellow; stigma small, short-oval, brown; wing-tip narrowly and vaguely infuscated; cord and outer portion of vein *Cu* narrowly seamed with brown, more evident on *m-cu* and *Cu;* Anal cells in large part slightly more infuscated, cell *1st A* with a yellowish streak adjoining vein *2nd A;* veins dark brown or brownish black, yellow in the more brightened fields. Sparse macrotrichia in outer ends of cells R_5 and M_1, especially the former. Venation: *Rs* shorter than *m-cu;* petiole of cell M_1 very variable in length, in the type about two and one-half times as long as *m*, in the paratype much shorter than *m*.

Abdomen orange yellow, the tergites with three interrupted black or brownish black stripes, the middorsal series larger but broken into oval spots, becoming obsolete on segments six or seven.

HABITAT: Mexico (Morelos). *Holotype*, ♀, Cuernavaca, altitude 5000 feet, August 14, 1944 (Krauss). *Paratopotype*, 1 ♀, August 24, 1944.

Generally similar to *Tipula (Trichotipula) vultuosa* sp. n., differing in important details of body-coloration and trichiation of the wings, especially the pattern of the thorax and the extensively blackened fore

femora, together with the restricted macrotrichia in the wing cells. Most of the described Mexican species of the subgenus bear a superficial resemblance to species of *Nephrotoma* Meigen.

Tipula (Lunatipula) dampfiana sp. n.

General coloration of mesonotal praescutum gray with four slightly differentiated darker gray stripes; posterior sclerites of notum and the pleura pale; wings with a brownish yellow tinge, the obliterative band before cord relatively inconspicuous; abdomen yellow, the tergites with very broad brownish black, nearly lateral stripes; male hypopygium with the tergal lobes narrow; inner dististyle with the posterior crest short and obtuse; outer basal lobe short and stout.

Male.—Length about 14 mm.; wing, 14.5 mm.; antenna about 4.5 mm.

Frontal prolongation of head buffy; nasus short and stout; first segment of palpus obscure yellow, the remainder brownish black. Antennae of moderate length, outer segments broken; first three segments yellow, the succeeding ones bicolored, the basal enlargement darker, stem yellow; on about the fourth and succeeding segments the stems more brownish yellow, outer segments uniformly blackened; flagellar segments moderately incised, longer than the verticils. Front and extreme anterior vertex pale, remainder of dorsum dark brownish gray throughout.

Pronotum infuscated. Mesonotal praescutum gray with four slightly differentiated darker gray stripes, the lateral praescutal borders broadly paler gray; scutal lobes dark gray, the median region very restrictedly obscure yellow; scutellum and mediotergite pale, pruinose. Pleura and pleurotergite chiefly pale yellow pollinose (the more cephalic pleurites destroyed by pinning). Halteres with stem obscure yellow, knob infuscated. Legs with the coxae yellow pollinose; trochanters yellow; femora obscure yellow, the tips rather narrowly dark brown; tibiae and basitarsi obscure yellow, the tips even more restrictedly darkened; outer tarsal segments more infuscated; claws (male) simple. Wings with a strong brownish yellow tinge, cell *Sc* clearer yellow; stigma pale brown, relatively inconspicuous, its proximal end paler; obliterative area before cord restricted and inconspicuous, appearing as an isolated prestigmal spot and a larger area that centers at cell *1st* M_2, more or less interrupted by darkened seams to the medial veins; veins brown, yellow in the brighter areas. Squama with relatively few bristles. Venation: *Rs* slightly less than twice *m-cu;* R_{1+2} entire but with its distal half paler and without trichia; petiole of cell M_1 longer than *m;* basal section of M_{3+4} subequal in length to *m*.

Abdomen yellow, the tergites with very broad and conspicuous brownish black stripes that are almost lateral in position, the pale borders being very narrow; basal sternites yellow; subterminal segments blackened, forming a broad ring; hypopygium more brownish yellow. Male hypopygium much as in *abscissa;* tergite with lateral lobes narrow but stouter than in *abscissa*, separated by a broad, gently convex median area. Inner dististyle with the posterior crest short and obtuse, not long-produced backward, as in *abscissa;* beak very short and blunt; outer basal lobe much shorter and stouter than in *abscissa*.

HABITAT: Mexico (Mexico). *Holotype*, ♂, Slopes of Mount Telapón, Valle de Mexico, altitude 2100–3500 meters, October 2, 1938 (Dampf); M. F. 7112.

I take particular pleasure in naming this species for my long-time friend and co-worker, Dr. Alfons M. Dampf. The fly is closely related to ***Tipula*** (***Lunatipula***) ***abscissa*** sp. n., differing in the pattern of the body and wings and, especially, in the structure of the male hypopygium, particularly the tergite and inner dististyle.

Tipula (Lunatipula) abscissa sp. n.

General coloration of mesonotum obscure yellow with brown markings; praescutal stripes four, entire; antennae strongly bicolored; thoracic pleura unpatterned; femora yellow, the tips narrowly brownish black; wings with a strong brownish tinge, with a continuous, very conspicuous obliterative area before the cord; abdominal tergites yellow, with very conspicuous sublateral black stripes that become more extensive and finally confluent on the outer segments; male hypopygium with the ninth tergite having the caudal border produced into a ventral polished plate, the lateral lobes terminating in small compressed blades; eighth sternite with conspicuous pencils and groups of setae.

Male.—Length about 13–14 mm.; wing, 15.5–16 mm.; antenna about 5 mm.

Frontal prolongation of head above yellow, slightly infuscated on sides; nasus distinct; palpi with proximal three segments obscure yellow, the terminal one brownish black. Antennae with basal three segments yellow, succeeding segments strongly bicolored, yellow, with black basal swellings, only the outer two or three segments uniformly darkened; basal swellings very small to scarcely thicker than the outer portion of segment; longest verticils somewhat exceeding the segments. Head with anterior portion buffy yellow, the posterior portion, including a central prolongation on anterior vertex, more grayish brown; orbits narrowly light gray; anterior vertex relatively narrow, about twice the diameter of scape; vertical tubercle not developed.

Pronotum obscure yellow, variegated with more brownish spots. Mesonotal praescutum obscure yellow, with four entire brown stripes, the intermediate pair more divergent at their anterior ends, leaving an extensive area of the ground, this pale stripe broad and conspicuous throughout its length; scutum with lobes light gray, extensively marked with brown, median area lighter brown; posterior sclerites of notum lighter gray, the scutellum with a vague darker area; mediotergite with an extensive sublateral brown area on either side, not reaching the sides of the sclerite; dorsal portion of pleurotergite infuscated. Pleura grayish yellow, unpatterned; dorsopleural membrane weakly infuscated. Halteres with stem obscure yellow, knob infuscated. Legs with the coxae and trochanters yellow; femora and tibiae yellow, the tips narrowly brownish black, the amount subequal on all legs; tarsi with basal two segments obscure yellow, the tips more darkened; outer tarsal segments brownish black; claws (male) simple. Wings with a strong brownish tinge, the prearcular and costal fields slightly more yellowed;

stigma relatively small, brown, the proximal end more yellowed; a continuous conspicuous whitish obliterative area extending from before the stigma across outer end of cell *R*, basal half of *1st* M_2 and into cell M_3; no post-stigmal brightening; veins brownish yellow, still brighter in the more yellowed areas. Venation: *Rs* about one-fourth longer than *m-cu;* R_{1+2} entire; petiole of cell M_1 and *m* subequal; *m-cu* on M_4 close to fork of M_{3+4}; cell *2nd A* broad.

Abdominal tergites reddish yellow with a very conspicuous sublateral black longitudinal stripe beginning near base of tergite two, narrowly interrupted at posterior borders of segments, becoming even more extensive on outer segments; lateral tergal borders very narrowly pale; basal sternites yellow, outer segments more infuscated and finally dark brown, including the hypopygium. Male hypopygium with the ninth tergite having a broad and deep dorsal furrow, the caudal border shallowly emarginate but with a more ventral shiny portion whose margin is convexly rounded; lateral lobes terminating in small compressed-flattened blades or points. Ninth sternite with the appendage low, simple, with long yellow setae. Outer dististyle dusky, slightly widened at near midlength. Inner dististyle with beak compressed-flattened; dorsal crest arising abruptly above the beak, setae sparse; posterior crest produced backward into a long pale blade, its margin microscopically erose; lower beak blackened, subtriangular; outer basal lobe relatively small, erect, provided with numerous long yellow setae. Aedeagus not much expanded at apex, produced into a small spinous point on either side. Eighth sternite with the lateral lobes low, tipped with compact pencils of long reddish setae that are directed inward and become decussate, at bases of lobes with more abundant smaller setae; lying more ventrad and nearer the midline on either side with a transverse row or brush of long golden setae, the outer portions bent inward to the midline.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Tepoztlan, September 4, 1944 (Krauss). *Paratopotype*, ♂.

The present fly is most nearly allied to *Tipula* (*Lunatipula*) *dampfiana* sp. n. and comparisons have been given under the account of that species. In the structure of the male hypopygium, especially of the tergite, these two species suggest forms such as *T.* (*L.*) *incisa* Doane but the relationship is not close.

Limonia Meigen

Limonia (Dicranomyia) perserena sp. n.

General coloration of the entire body pale greenish yellow or white; halteres entirely pale; legs whitened; wings hyaline, the stigma very pale brown; a vague darkening over the cord; cell M_2 open by the atrophy of the basal section of M_3, cell *2nd* M_2 subequal in length to or shorter than its petiole; *m-cu* at fork of *M;* cell *2nd A* wide; male hypopygium with the rostral prolongation of ventral dististyle short, the two spines stout and spikelike.

Male.—Length about 5–6 mm.; wing, 6–7.5 mm.

Rostrum moderately long, testaceous yellow; palpi pale. Antennae with scape yellow, pedicel brown, flagellum somewhat paler brown;

flagellar segments oval. Head above yellow, even more orange on central part of vertex; anterior vertex broad, nearly two and one-half times the diameter of scape.

Pronotum yellow. Mesonotum pale greenish white on anterior portion of praescutum, the posterior two-thirds of the latter and the remainder of notum a very little darker, unpatterned. Pleura yellow. Halteres entirely pale. Legs whitened, only the outer tarsal segments a trifle darker. Wings hyaline, the prearcular and costal regions a trifle more yellowed; stigma short-oval, very pale brown; a similarly vague darkening over the cord; veins yellow, the cord a trifle more darkened. Venation: *Sc* short, Sc_1 ending a distance before origin of *Rs* about equal to from one-fourth to one-sixth the length of the latter, Sc_2 apparently atrophied; free tip of Sc_2 and R_2 in transverse alignment; cell M_2 open by the atrophy of basal section of M_3; cell *2nd* M_2 subequal in length to or shorter than its petiole; *m-cu* at fork of *M;* cell *2nd A* wide.

Abdomen obscure yellow, including the hypopygium. Male hypopygium with the posterior border of tergite emarginate, the lobes broad, with strong setae. Basistyle with the ventromesal lobe large, simple. Dorsal dististyle a strongly curved hook, the outer third rather strongly narrowed. Ventral dististyle large and fleshy, its area at least three times that of the basistyle; rostral prolongation short and stout, at apex even further produced into a more flattened dark-colored flange; the two rostral spines are placed close together near the base of prolongation; stout and spikelike, their tips obliquely acute. Gonapophysis with mesal-apical lobe erect, the apex bent slightly laterad.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Tepoztlan, September 4, 1944 (Krauss). *Paratypes*, 2 ♂♂, Cuernavaca, October, 1944, March, 1945 (Krauss).

Limonia (Dicranomyia) perserena is readily distinguished from all other regional members of the subgenus by the venation, especially the cell M_2 open by the atrophy of the basal section of M_3, a very rare condition in the subgenus.

Limonia (Geranomyia) disparilis sp. n.

General coloration of mesonotum dull black, the praescutum almost covered by blackened stripes; rostrum relatively short, black throughout; wings with a strong dusky tinge, unmarked except for the oval, darker brown stigma; *Sc* short; abdomen, including hypopygium, brownish black; male hypopygium with two rostral spines on ventral dististyle, these very unequal in size, the more basal one largest, placed at the base of prolongation on the face of the style itself; second spine reduced to a seta, lying more distad at the base of the major spine; apex of prolongation obtusely rounded.

Male.—Length, excluding rostrum, about 4.5 mm.; wing, 5 mm.; rostrum about 1.8 mm.

Rostrum relatively short, black throughout; palpi black. Antennae black throughout; flagellar segments oval, the outer ones gradually decreasing in size; verticils short. Head black.

Mesonotum chiefly dull black, the praescutum almost covered by blackened stripes, reducing the paler ground to humeral areas. Pleura

black, slightly plumbeous. Halteres black, the base of stem yellow. Legs with coxae brownish black, the posterior pair paler; trochanters obscure yellow; remainder of legs broken. Wings with a strong dusky tinge, cell *Sc* even darker; stigma oval, darker brown; veins brown. Venation: *Sc* short, Sc_1 ending just beyond the origin of *Rs*, Sc_2 at its tip; *m-cu* just before the fork of *M;* cell *2nd A* of moderate width.

Abdomen, including hypopygium, brownish black. Male hypopygium with the tergite transverse, the caudal margin gently emarginate. Ventral dististyle relatively small, the rostral prolongation moderately long, its apex obtusely rounded; two rostral spines of very different sizes, the more basal one largest, placed on the face of style at base of prolongation, arising from a conspicuous cylindrical tubercle, the spine short and straight; second spine reduced to a slender seta, from a correspondingly tiny globular tubercle, placed close to the base of the outer face of the major tubercle; prolongation beyond the outer spine exceeding in length the spine itself. Gonapophysis with mesal-apical lobe relatively broad, narrowed to a spinous apical point, the lateral margin vaguely toothed.

HABITAT: Mexico (Chiapas). *Holotype*, ♂, Finca Victoria, altitude 900 meters, June 29, 1935 (Dampf); M. F. 4709.

The present fly is readily told by the structure of the male hypopygium. In this latter respect it is most similar to ***Limonia*** (***Geranomyia***) ***versuta*** Alexander, ranging from southern Mexico to Colombia, but differs in all details. The general appearance of the two flies is quite dissimilar and it does not appear that they are closely allied.

Orimarga Osten Sacken

Orimarga (Orimarga) tartarus sp. n.

General coloration of thorax brownish gray, the praescutal stripes ill-delimited; antennae and legs blackened; wings with a strong blackish tinge, the prearcular and costal fields whitened; vein R_{1+2} elongate, nearly three times R_{2+3}; R_1 beyond the free tip of Sc_2 about one-half longer than R_{2+3}; cell M_3 longer than its petiole; *m-cu* about twice its length before the fork of *M;* cell *2nd A* greatly widened on its basal portion; male hypopygium with the gonapophyses appearing as short straight spikes.

Male.—Length about 5.5–6 mm.; wing, 5.5–6 mm.

Female.—Length about 5.5–6.5 mm.; wing, 6–7 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments short-oval. Head above brownish gray, the front light silvery gray; anterior vertex relatively broad, about three times the diameter of scape.

Pronotum dark brown, sparsely pruinose. Mesonotal praescutum brownish gray with four ill-delimited darker brown stripes, the interspaces very obscured, the lateral praescutal borders broadly light gray; posterior sclerites of notum gray, the scutal lobes darkened. Pleura gray, the ventral sternopleurite more blackened; a more or less evident blackened stripe lying more dorsally. Halteres with stem brown, narrowly yellow at base, knob blackened. Legs with the fore and middle coxae darkened, pruinose, posterior coxae conspicuously yellow; tro-

chanters darkened; remainder of legs dark brown or brownish black. Wings with a strong blackish tinge, the prearcular and costal fields whitish; outer end of cell R_5 slightly whitened; veins dark brown. Outer veins of wing, including both radial and medial fields, with relatively abundant macrotrichia. Venation: Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 a short distance from its tip; R_{1+2} elongate, nearly three times R_{2+3}; free tip of Sc_2 preserved; R_1 about one-half longer than R_{2+3}; inner end of cell R_3 only slightly arcuated, about on a level with cell M_2; cell M_3 longer than its petiole; *m-cu* oblique, about twice its length before the fork of *M;* cell *2nd A* greatly widened on its basal portion.

Abdomen, including hypopygium, brownish black to black. Male hypopygium with the basistyle unmodified, the setae simple, much more numerous on mesal face. Outer dististyle long and slender, gradually narrowed to the acute tip. Inner dististyle about as long, with a single row of strong setae down the face, near base of style with a stout lobe bearing six to eight strong setae. Gonapophysis a short straight spike, the tip blunt.

HABITAT: Mexico (Morelos). *Holotype,* ♂, Cuernavaca, altitude 5000 feet, May 1945 (Krauss). *Allotopotype,* ♀, pinned with type. *Paratopotypes,* numerous ♂ ♀, August 1944–May 1945 (Krauss).

In its somewhat peculiar venation, the present fly suggests species such as *Orimarga (Orimarga) excessiva* Alexander and *O. (O.) saturnina* Alexander, yet differs in the proportions of the radial elements, as described. It further differs from all other generally similar regional forms by the very strongly darkened wings.

Orimarga (Orimarga) subtartarus sp. n.

Male.—Length about 5 mm.; wing, 4.5–5.5 mm.

Female.—Length about 6 mm.; wing, 5.2 mm.

Very similar to *tartarus,* differing especially in color and in the venational details. Legs paler, the femoral tips narrowly more darkened. Wings brownish gray, not conspicuously blackened, as in *tartarus.* Venation: R_{1+2} shorter, less than twice R_{2+3}; free tip of Sc_2 opposite the fork of *Rs; m-cu* only a little more than its own length before the fork of *M.*

HABITAT: Mexico (Jalisco). *Holotype,* ♂, Tequila, altitude 3900 feet, along an irrigation canal, July 28, 1934 (Dampf); M. F. 3568. *Allotopotype,* ♀, pinned with type. *Paratopotype,* 1 ♂.

Oxydiscus de Meijere

Oxydiscus (Oxydiscus) morelosensis sp. n.

Dark chestnut brown; halteres whitened; wings with a weak brownish tinge, restrictedly patterned with darker brown; macrotrichia of wing cells relatively numerous.

Female.—Length about 5 mm.; wing, 5 mm.

Rostrum and palpi black. Antennae black throughout; outer flagellar segments oval. Head dark brown.

Thoracic dorsum almost uniformly dark chestnut brown, without

pattern; scutellum a little darker behind. Pleura somewhat darker brown, especially on the ventral portion. Halteres whitened. Legs with the coxae yellow, the fore pair somewhat darker; trochanters obscure yellow; remainder of legs broken. Wings with a weak brownish tinge, the prearcular and costal fields a little paler; a restricted brown pattern, including very narrow seams at origin of *Rs*, Sc_2, cord, outer end of cell *1st* M_2 and over R_2, the remainder of the stigmal area paler brown but extensive; veins pale brown, a little darker in the clouded portions. Macrotrichia in outer wing cells, including several in cell R_2 beyond the stigma, extending to cell *1st A*, becoming more sparse in the posterior cells. Venation: Sc_1 ending a short distance beyond the fork of *Rs*, Sc_2 some distance from its tip; *Rs* obliquely angulated at origin; cell R_3 deeper than in *oaxacensis;* cell M_1 shorter and with the enclosing branches more divergent; *m-cu* more than its own length beyond the fork of *M*.

Abdominal tergites brown, the posterior borders of the outer segments narrowly paler; sternites obscure brownish yellow.

HABITAT: Mexico (Morelos). *Holotype*, ♀, Cuernavaca, altitude 5000 feet, August 14, 1944 (Krauss).

The most similar species and the only other described regional one having patterned wings is *Oxydiscus* (*Oxydiscus*) *oaxacensis* Alexander, which has the wing pattern heavier and shows slight venational differences, as indicated above. In this latter fly, the macrotrichia of the cells are somewhat less numerous, as shown by the lack of poststigmal setae in cell R_2.

Gnophomyia Osten Sacken

Gnophomyia (Gnophomyia) subobliterata sp. n.

Size medium (wing 6 mm. or less); general coloration of mesonotal praescutum and scutal lobes blackened, the surface sparsely pruinose, the humeral and lateral portions of praescutum yellow; thoracic pleura with a more or less entire brown longitudinal stripe; legs brownish yellow, outer tarsal segments blackened; wings with a weak brownish tinge, stigma lacking; outer radial veins strongly decurved at tip, cell R_2 at margin very extensive; vein R_2 atrophied or its position barely indicated; *m-cu* at about two-thirds its own length beyond the fork of *M;* male hypopygium with the inner dististyle black, its lower margin with three or four very long and powerful setae; phallosome with the upper plate conspicuously emarginate to produce two blackened lobes.

Male.—Length about 5.5 mm.; wing, 5.8 mm.; antenna about 1.5 mm.

Female.—Length about 6 mm.; wing, 6 mm.

Rostrum obscure yellow; palpi brown. Antennae with scape and pedicel light brown to brown, flagellum black; flagellar segments elongate, the longest verticils exceeding the segments. Head gray.

Pronotum light yellow above, more darkened on sides. Mesonotal praescutum and scutum blackened, the surface sparsely pruinose, the humeral and lateral portions obscure yellow; vicinity of the suture more or less reddened; scutellum yellow, weakly darkened basally; mediotergite brownish black, the cephalic portion vaguely more brightened. Pleura and pleurotergite obscure yellow, with a more or less distinct dark brown dorsal stripe, more nearly complete in female, in male more

broken behind by the pale pleurotergite. Halteres blackened, base of stem yellow. Legs with the coxae and trochanters yellow, fore coxae weakly more darkened; remainder of legs obscure brownish yellow, outer tarsal segments blackened. Wings with a weak brownish tinge, the extreme base more yellowed; stigma lacking; veins brown, the prearcular ones brighter. Venation: Outer branches of *Rs* strongly decurved, cell R_2 at margin thus being very extensive; vein R_2 atrophied or barely indicated, placed just beyond the fork of R_{2+3+4}; *r-m* at fork of *M;* cell *1st* M_2 elongate, a little longer than vein M_4; *m-cu* about two-thirds its own length beyond the fork of *M*.

Abdominal tergites dark brown, the pleural membrane and hypopygium more yellowed; ovipositor with cerci compressed, yellow, the tips narrowed and slightly more darkened; cerci hairy to the tips. Male hypopygium having the basistyle with a small pale subglobular lobule on mesal face at base. Outer dististyle glabrous, relatively slender, gradually narrowed outwardly, the tip narrowly obtuse, both base and apex narrowly infuscated, the intermediate portion pale. Inner dististyle much shorter, the base enlarged, the free outer portion relatively slender, the tip very obtuse to slightly dilated; lower or ventral margin of style near base of free portion with three or four setae of unusual length, the longest only a little shorter than the free portion alone. Phallosome with the upper plate conspicuously emarginate to produce two blackened lobes; the lower plate with a few microscopic blackened points that show in the emargination.

HABITAT: Mexico (Morelos). *Holotype,* ♂, Tepoztlan, September 4, 1944 (Krauss). *Allotopotype,* ♀, pinned with the type.

From other generally similar regional species that have the venation of the radial field somewhat as in the present fly, especially *Gnophomyia* (*Gnophomyia*) *acricula* Alexander, this insect is most readily separated by the distinctive hypopygium, including both dististyles and the phallosome.

Gnophomyia (Gnophomyia) subarcuata sp. n.

Allied to *arcuata;* general coloration of head and thorax dark plumbeous gray; antennae black throughout; halteres brownish black, the apex of knob very slightly reddened; wings hyaline, stigma very slightly indicated; vein R_{2+3+4} moderately arcuated, R_2 subequal to or somewhat longer than R_{3+4}; cerci elongate, with scattered coarse setae.

Female.—Length about 7 mm.; wing, 5.8 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments oval; verticils relatively inconspicuous. Head plumbeous gray.

Pronotum dark gray, the lateral portions of praescutum restrictedly obscure yellow. Mesonotum dark plumbeous gray, the posterior sclerites and the pleura clearer gray. Halteres brownish black, the apex of knob very slightly reddened. Legs with coxae gray pruinose; remainder of legs black. Wings hyaline, stigma barely darkened; veins dark brown. Venation: Sc_1 ending about opposite five-sixths *Rs;* R_{2+3+4} moderately arcuated, conspicuously less so than in *arcuata;* R_2 subequal to or a little longer than R_{3+4}; vein R_3 shorter than in *arcuata;* cell *1st* M_2 strongly narrowed at proximal end; *m-cu* close to the fork of *M*.

Abdomen brownish black. Cerci elongate, fleshy, the tips notched; surface with scattered coarse setae, including some of large size. The emarginate tips of the cerci appear to represent a normal condition.

HABITAT: Mexico (Chiapas). *Holotype*, ♀, Finca Vergel, altitude 800 meters, May 23, 1935 (Dampf); M. F. 4268.

Gnophomyia* (*Gnophomyia*) *subarcuata is allied to species such as *G.* (*G.*) *arcuata* Alexander or *G.* (*G.*) *diazi* Alexander, differing especially in details of venation and in the structure of the ovipositor.

Gonomyia Meigen

Gonomyia (Lipophleps) rastriformis sp. n.

Belongs to the *cinerea* group; all femora differently patterned; wings with cell M_2 open by the atrophy of basal section of M_3; male hypopygium with the outer dististyle an unusually stout simple rod; intermediate style widely dilated beyond midlength, the margin of the flange darkened and microscopically serrulate; inner style a clavate pale lobe, its lower edge remote from the apex bearing a small mace-like structure that terminates in several small points.

Male.—Length about 4 mm.; wing, 4.2 mm.

Rostrum dark brown; palpi black. Antennae with the basal segments yellow above, more infuscated beneath; basal flagellar segments pale, the outer ones passing into brown. Head with the center of vertex brownish gray, the remainder conspicuously yellow.

Pronotum and pretergites yellow, the scutum slightly darker medially. Mesonotum brownish gray, the central region of scutum more orange, with a narrow darker median line; posterior border of scutellum, broad lateral borders of mediotergite and the anapleurotergite yellow, the katapleurotergite infuscated; humeral and lateral portions of praescutum obscure yellow. Pleura obscure brownish yellow dorsally, the ventral half striped longitudinally with darker brown and yellow, including a very narrow longitudinally more dorsal stripe, extending from behind the fore coxae to the base of abdomen, passing through the root of the halteres; ventral sternopleurite and meral region broadly paler brown. Halteres yellow, the knob weakly darkened. Legs with the coxae yellow, the bases of the fore and middle pairs narrowly infuscated; trochanters yellow; all legs differently patterned; fore femora black, the extreme bases paler; tibiae white, the bases narrowly, the tips a little more extensively blackened; tarsi brownish black, the basitarsi immediately beyond origin obscure yellow; middle femora yellow, the tips rather narrowly blackened, including about the distal seventh; remainder of middle legs about as on fore pair; posterior femora obscure yellow, with a narrow subterminal pale brown ring, preceded by a vaguely brighter yellow area; tibiae white, with an exceedingly narrow subterminal brown ring, the extreme base vaguely darkened; basitarsi with about the proximal two-thirds yellow, the remainder of tarsi black. Wings with a brownish gray ground, the costal border more whitened, expanded in the vicinity of the darker brown stigma to form conspicuous prestigmal and poststigmal brightenings; a vague darkening along cord, indicated by a deepening in color of the veins; remaining veins paler brown, those in the whitened

fields white or pale yellow. Venation: Sc_1 ending a distance before origin of *Rs* nearly as long as this latter vein alone, Sc_2 a short distance from the tip; cell M_2 open by the atrophy of basal section of M_3; *m-cu* close to the fork of *M*.

Abdomen brown, the posterior borders of the segments pale, including two pale spots, narrowly separated from one another by a median dark projection; hypopygium chiefly darkened. Male hypopygium with the outer dististyle an unusually long and strong slender rod, approximately four-fifths as long as the major second style, the tip acute and narrowly blackened, microscopically roughened; intermediate style largest, appearing as a flattened blade, bearing on inner edge a blackened microscopic scabrous spine or arm; beyond this arm the style is widely dilated, the flange narrowly darkened and microscopically serrulate on margin; inner style or branch a chiefly pale clavate lobe, provided with numerous long strong setae; on lower edge, remote from the apex, with a blackened mace-like structure that terminates in several small points.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, August 24, 1944 (Krauss).

The most similar described species are *Gonomyia* (*Lipophleps*) *helophila* Alexander and *G.* (*L.*) *monacantha* Alexander, which differ very conspicuously in the structure of the male hypopygium.

Gonomyia (Gonomyia) stellata sp. n.

Allied to *mexicana:* general coloration of mesonotum dark brown, the pleura but slightly patterned; wings with a weak dusky tinge, the prearcular and costal fields more whitened; *Rs* a little shorter than R_{2+3+4}; *m-cu* at near two-fifths the length of cell *1st* M_2; male hypopygium with the outer blade of dististyle blackened, the outer margin with about four strong spines, additional to the longer terminal one, with a longer blackened rod in the axil of the pale inner lobe; apophyses paired, elongate, slender, each bearing a long branch at near two-thirds the length, the tips of all branches terminating in an acute spinous point.

Male.—Length about 5 mm.; wing, 5.5 mm.

Head broken.

Pronotum brown medially, pale on sides; pretergites restrictedly pale yellow. Mesonotal praescutum and scutal lobes chiefly covered by a dark brown discal area, the surface sparsely pruinose; lateral praescutal borders restrictedly obscure yellow; median region of scutum vaguely brightened; scutellum and mediotergite dark brown, the posterior border of the former obscure yellow. Pleura and pleurotergite almost uniformly yellow or testaceous yellow, the mesepisternum vaguely patterned with darker, especially on the ventral sternopleurite. Halteres with stem dirty white, the extreme base brighter; knobs of halteres infuscated. Legs with coxae and trochanters yellow, the fore coxae weakly infuscated; remainder of legs dark brown, the femoral bases restrictedly brightened. Wings with a weak dusky tinge, the prearcular and costal fields more whitened; stigmal area diffuse, more darkened; veins brown, paler in the whitened areas. Costal fringe moderately long and dense. Venation: Sc_1 ending opposite the origin of *Rs*, Sc_2

a short distance from its tip; *Rs* a little shorter than R_{2+3+4}, the latter gently arcuated on proximal half; vein R_3 long and only slightly oblique; cell *1st* M_2 gently widened outwardly, nearly as long as vein M_4; *m-cu* approximately its own length beyond the fork of *M* or at near two-fifths the length of cell *1st* M_2.

Abdominal tergites dark brown, sternites paler; hypopygium chiefly pale brown. Male hypopygium with the apical lobe of basistyle small, oval. Dististyle distinctive; outer blade blackened, flat, terminating in a sharp spine, the outer margin with about four other smaller spines, producing a more or less distinct stellate appearance; at base of this blade and in its axil with a longer blackened rod or spine; inner lobe pale, terminating in the usual two fasciculate setae and with several other smaller bristles. Phallosome distinctive; gonapophyses paired, elongate, very slender, at near two-thirds the length each forked into a slender branch that is slightly longer than the axial one, this more glabrous, all branches terminating in subequal acute spinous points; surface of stem and the axial branch with microscopic scabrous points. Aedeagus stout, gently arcuated, at apex with a deep and narrow split; both apical points with coarse spines or fimbriations.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, August 25, 1944 (Krauss).

Gonomyia (*Gonomyia*) *stellata* is entirely distinct from the other regional species of the subgenus, especially in the structure of the male hypopygium. The dististyle and phallosome, particularly the elongate, profoundly branched gonapophyses, are noteworthy. In the nature of the phallosome the fly is closest to species such as *G.* (*G.*) *mexicana* Alexander but the relationship is not particularly close.

Gonomyia (Gonomyia) remigera sp. n.

Allied to *flavibasis;* mesonotum chiefly dark brown, sparsely pruinose; scutellum chiefly dark brown; pleura yellow with a narrow dark brown dorsal stripe; halteres infuscated; wings with cell M_2 open by the atrophy of the basal section of M_3; male hypopygium with the outer dististyle on outer margin nearing a blackened triangular lobe or flange; inner dististyle with the outer arm a flattened elongate pale blade; phallosome with a single strongly curved black spine, beyond which point the entire phallosome is pale, not terminating in a spine.

Male.—Length about 3.5 mm.; wing, 4 mm.

Rostrum and palpi black. Antennae with the scape and pedicel yellow, flagellum dark brown; flagellar segments oval. Head above obscure yellow, the central portion of vertex more infuscated.

Pronotum and pretergites light yellow. Mesonotum almost uniformly dark brown, sparsely pruinose; humeral region and lateral borders of praescutum light yellow, more reddened at and near the suture; central region of scutum obscure yellow; scutellum chiefly dark brown, paler posteriorly; mediotergite yellow, more infuscated medially and especially behind. Pleura yellow, with a narrow dark brown dorsal stripe extending from the cervical region to the base of abdomen, passing beneath the root of the halteres; ventral pleurites a little more yellowed than the broad pleural stripe. Halteres infuscated. Legs

with the coxae and trochanters yellow; remainder of legs dark brown, the femoral bases somewhat paler. Wings with a grayish tinge, the prearcular and costal fields more yellowed; stigma oval, medium brown; veins pale brown, more yellowed in the brightened fields. Venation: Sc_1 ending far before the origin of *Rs*, the distance being only a little shorter than *Rs* alone; *Rs* and R_{2+3+4} strongly arcuated, the latter a little shorter; cell M_2 open by the atrophy of basal section of M_3; *m-cu* close to the fork of *M*.

Abdominal tergites dark brown, the incisures paler; sternites and hypopygium yellow. Male hypopygium with the outer dististyle elongate, on outer margin with a strong blackened triangular lobe that is not produced into a spine. Inner dististyle distinctive, the outer arm a flattened elongate pale blade; main body of style subequal in length but stouter. Phallosome with a single strongly curved black spine; beyond this point the phallosome entirely pale, its tip irregularly truncate, not produced into a spine; some distance before tip with a long-oval pale flange or lobe.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, August 14, 1944 (Krauss).

Gonomyia (Gonomyia) remigera is most similar to species such as *G. (G.) flavibasis* Alexander (*tuberculata* Alexander), differing especially in the structure of the male hypopygium, particularly of the dististyles and phallosome.

Gonomyia (Gonomyia) ostentator sp. n.

Allied to *expansa;* size large (wing, male, 5.5 mm.); rostrum black; antennae with scape and pedicel yellow; thoracic pleura yellow, with a broad dorsal dark brown stripe and a shorter and narrower ventral one; knobs of halteres darkened; wings with a grayish tinge, the stigma and a vague seam over the cord darker; cell *1st* M_2 closed; male hypopygium with the outer dististyle an elongate flattened blade, not provided with a lateral spine; inner dististyle with the outer margin of the main body elevated into a glabrous darkened flange, subequal in area to the dusky outer blade of the style; phallosome with a single well-developed spine, the apex beyond this large, complicated by outgrowths, the actual tip pale and truncated.

Male.—Length about 5 mm.; wing, 5.5 mm.

Female.—Length about 6 mm.; wing, 6 mm.

Rostrum and palpi black. Antennae with scape and pedicel light yellow, flagellum dark brown; basal flagellar segments long-oval. Head above orange, the center of vertex more or less infuscated.

Pronotum and pretergites light yellow. Mesonotal praescutum and scutum chiefly dark brown, the median region of the latter, and the scutellum, obscure brownish yellow; lateral praescutal borders yellow; mediotergite yellow, the posterior border broadly dark brown, the basal portion with a more or less developed central spot. Pleura and pleurotergite yellow, with a conspicuous dorsal dark brown stripe extending from the cervical sclerites to the mediotergite, as described; a second narrower dark stripe on the ventral sternopleurite, crossing the bases of the mid-coxae onto the meron; the broad pale stripe between these

darkened lines more whitened than the remainder of pleura. Halteres with stem pale brown, darker at extreme base, knob dark brown. Legs with the coxae yellow, the middle pair restrictedly darkened, as described; trochanters yellow; remainder of legs brownish black to black. Wings with a grayish tinge, the prearcular and costal fields somewhat more yellowed; stigma small, oval, brown; a vaguely indicated darkened cloud over the cord; veins brown, more yellowed in the brightened fields. Venation: *Sc* short, Sc_1 ending a distance before origin of ***Rs*** that is about two-fifths the length of the latter, Sc_2 near its tip; ***r-m*** arcuated, at or close to the fork of *Rs*, the basal section of R_5 short to lacking; vein R_4 elongate, decurved toward wing tip, more than three times vein R_3; cell *1st* M_2 closed; ***m-cu*** at or close to fork of ***M***.

Abdominal tergites dark brown, the posterior angles or even the entire border yellow; sternites and hypopygium yellow. Male hypopygium with the basistyle not produced apically. Outer dististyle an elongate flattened blade, the outer surface with very long conspicuous setae; face of style with a long oblique darkened flange extending over about one-half the length of the organ. Inner dististyle shorter, the main body stout, its outer margin elevated into a glabrous darkened flange, subequal in area to the flattened dusky outer blade of the style, the latter with the seta placed far basad; fasciculate seta at apex of a small lobe. Phallosome very large and complex, with a single developed, very powerful blackened spine near base, the second spine very small and weak; beyond the spines the phallosome is greatly expanded and complex in structure, bearing an outer pale blade-like appendage, the actual tip arising from the face of the expanded body, strongly curved, truncated and pale at tip.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, March, 1945 (Krauss). *Allotopotype*, ♀, August 25, 1944 (Krauss).

Although similar and related to species such as *Gonomyia* (*Gonomyia*) *expansa* Alexander and *G.* (*G.*) *remota* Alexander, the present fly is quite distinct in many details of structure of the male hypopygium, especially both dististyles and the phallosome.

Molophilus Curtis

Molophilus (Molophilus) procax sp. n.

Belongs to the *gracilis* group and subgroup; general coloration black, evidently pruinose; antennae short; knobs of halteres obscure yellow; fore legs blackened, middle and posterior femora with bases broadly yellowish; wings with a strong brownish tinge; basal section of R_{4+5} relatively short, only about one-third R_{2+3}; male hypopygium with the two dististyles subequal in length, of distinctive conformation.

Male.—Length about 4.5 mm.; wing, 5 mm.

Rostrum and palpi black. Antennae short, black throughout; flagellar segments cylindrical, with long coarse verticils that exceed the segments in length. Head black, pruinose.

Pronotum black, the scutellum and pretergites yellow. Mesonotum chiefly black, evidently pruinose, the surface of the unique type badly discolored; humeral region of praescutum restrictedly light yellow;

scutellum behind vaguely more reddened; mediotergite behind and the pleurotergite reddish brown. Pleura blackened, presumably pruinose in fresh specimens. Halteres with stem dusky, knob obscure yellow. Legs with fore coxae infuscated; remaining coxae yellow; trochanters yellow; fore legs blackened; middle and posterior femora with the bases broadly yellowish, the remainder blackened. Wings with a strong brownish tinge, vaguely more suffused in cell *M* adjoining vein *Cu;* prearcular field yellow; veins brown. Venation: Sc_1 ending about opposite R_2; basal section of R_{4+5} relatively short, only about one-third R_{2+3}; petiole of cell M_3 about one-half longer than the gently sinuous *m-cu;* vein *2nd A* ending nearly opposite the posterior end of *m-cu*.

Abdomen, including hypopygium, black. Male hypopygium distinctive; ventral lobe of basistyle slender, clavate; mesal lobe broader and slightly shorter, near apex with the margin produced laterad into a small blackened tooth. Both dististyles arising close together in the notch of the basistyle. Outer dististyle stouter, on outer half strongly sinuous, the apex produced into a slender upcurved spine; outer margin with a few coarse retrorse spinulae, the more basal ones larger; inner margin at beginning of the sinuous outer portion with numerous microscopic spinulae. Inner dististyle a slender simple rod, narrowed very gradually into a long straight spine, the outer surface of style for most of its length with appressed spinulae, the surface with further abundant setulae and a few long scattered setae. Phallosomic structure terminating in a small obtuse point; surface of plate with abundant setulae. Aedeagus elongate.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, June, 1945 (Krauss).

The only described species with which the present fly requires comparison is *Molophilus* (*Molophilus*) *retrorsus* Alexander, which has the male hypopygium entirely different in structure.

Molophilus (Molophilus) bellona sp. n.

Belongs to the *plagiatus* group; size relatively large (wing, male, about 5 mm. or more); antennae of male elongate, the flagellar segments fusiform, with long outspreading verticils; general coloration of body almost uniformly dark brown; halteres obscure yellow; wings subhyaline, the color almost concealed by the unusually long and conspicuous trichia of the veins, these concentrated into patches along the cord; *m-cu* sinuous; male hypopygium with the basistyle an unusually long and slender, nearly straight rod, its apex slightly curved.

Male.—Length about 4–4.3 mm.; wing, 4.8–5.4 mm.; antenna, about 2–2.1 mm.

Rostrum and palpi dark brown. Antennae brownish black throughout, elongate in male, nearly one-half as long as body; flagellar segments elongate-fusiform, with whorls of long outspreading verticils at the thickest portion. Head dark gray.

Thorax almost uniformly dark brown, sparsely pruinose, especially on notum. Halteres obscure yellow. Legs with the coxae and trochanters testaceous yellow; remainder of legs chiefly dark brown to almost black. Wings with the ground subhyaline, almost concealed

by the unusually long conspicuous trichia on the veins, more concentrated on the cord to produce a vague spotted appearance; prearcular field a trifle paler. Venation: R_2 lying shortly beyond the level of *r-m;* petiole of cell M_3 about twice as long as the obliquely sinuous *m-cu;* vein *2nd A* long and sinuous, ending about opposite one-fourth the length of the petiole of cell M_3.

Abdomen, including hypopygium, brownish black to black. Male hypopygium with the beak of the basistyle acute. Outer dististyle unequally bifid at apex, the inner arm longer. Basal dististyle an unusually long slender rod, nearly straight, its apex slightly curved, the extreme base constricted.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Harmsen's Place, Cuernavaca, altitude 5000 feet, July 16, 1930 (Dampf); M. F. 1689. *Paratopotypes*, 2 ♂♂, September 24, 1928; M. F. 1416; *paratype*, 1 ♂, Parque de Revolucion, in the bishop's garden, March 3, 1938; M. F. 1325.

This fly is allied to species such as *Molophilus* (*Molophilus*) *falx* Alexander, *M.* (*M.*) *subsagax* Alexander, and others, differing especially in the structure of the male hypopygium, particularly the basal dististyle.

Molophilus (Molophilus) incognitus sp. n.

Belongs to the *plagiatus* group; general coloration light brown, sparsely pruinose; antennae (male) short, brown throughout; femora and tibiae obscure yellow, infuscated at tips; wings yellowish subhyaline, veins and trichia infuscated; male hypopygium with the arms of the outer dististyle unequal, the lower one stouter, strongly upturned at apex; basal dististyle a long gently curved blackened rod, narrowed to the acute tip.

Male.—Length about 4–4.5 mm.; wing, 4.5–5 mm.

Rostrum and palpi black. Antennae short, if bent backward scarcely reaching the wing root, brown throughout; flagellar segments oval, with long verticils. Head dark gray.

Pronotum yellowish brown; pretergites light yellow. Mesonotum almost uniformly light brown, sparsely pruinose; humeral region of praescutum obscure yellow; in cases, the scutellum vaguely brightened; suture between mediotergite and pleurotergite yellow. Pleura infuscated. Halteres weakly darkened, base of stem restrictedly yellow. Legs with the coxae and trochanters obscure yellow; femora and tibiae obscure yellow, broadly infuscated at tips; tarsi brownish black. Wings yellowish subhyaline, the ground much hidden by long brown macrotrichia; veins and trichia infuscated, the latter more or less concentrated along the cord. Venation: R_2 lying a short distance beyond the level of *r-m; m-cu* oblique, about one-half the petiole of cell M_3; vein *2nd A* relatively long and sinuous, ending about opposite the base of the petiole of cell M_3.

Abdomen dark brown, including hypopygium. Male hypopygium with the beak of basistyle very slender, blackened. Outer dististyle with the arms unequal, the lower stouter, strongly upturned at apex. Basal dististyle a long simple gently curved blackened rod, enlarged at

base, very gradually narrowed to the acute tip. Aedeagus relatively short and slender.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, July 16, 1930 (Dampf); M. F. 1689. *Paratopotypes*, ♂♂, February 13–27, 1932 (C. C. Plummer); Dampf M. F. 2480, 2482, 2483, 2491; *paratypes*, ♂♂, Yautepec, altitude 3900 feet, July 17, 1930 (Dampf); M. F. 1697.

Most similar to ***Molophilus*** (***Molophilus***) ***severus*** Alexander, differing in all details of structure of the male hypopygium, including both dististyles and the aedeagus.

Molophilus (Molophilus) telerhabda sp. n.

Belongs to the ***plagiatus*** group; size small (wing, male, 4.5 mm.); antennae short; mesonotum and pleura brownish gray; legs dark brown to black; wings with a weak brownish tinge; male hypopygium with the basal dististyle a very long delicate simple rod that terminates in about a dozen small acute spinules, arranged in a compact group at apex.

Male.—Length about 4 mm.; wing, 4.5 mm.; antenna about 1.1 mm.

Rostrum brownish gray, conspicuously hairy; palpi dark brown. Antennae short, dark brown throughout; flagellar segments subcylindrical, the ends truncated; longest verticils of more basal segments very long, fully three times the segments, those of outer segments shorter. Head light gray.

Pronotum brown; pretergites light yellow. Mesonotum chiefly dark brown, pruinose with gray; humeral region of praescutum more obscure yellow. Pleura dark plumbeous gray; dorsopleural region dusky. Halteres pale yellow. Legs with the coxae dark brown; trochanters obscure brownish yellow; femora brown, paler basally; remainder of legs passing through dark brown to black; a modified region at base of fore tibia. Wings with a weak brownish tinge, the prearcular and costal fields light yellow; veins pale brown, the trichia a little darker. Venation: R_2 lying a short distance beyond level of *r-m; m-cu* straight, a little less than one-half the petiole of cell M_3; vein *2nd A* relatively long, ending just beyond *m-cu*.

Abdomen, including hypopygium, dark brown. Male hypopygium with the beak of basistyle slender. Outer dististyle with the stem long and slender, arms unequal, the inner one slender and sinuous. Basal dististyle distinctive, appearing as a very long delicate simple rod that juts caudad beyond the level of the basistyle; outer half of approximately uniform diameter or beoming even thicker toward the tip, the apex terminating in about a dozen small acute spinules, their points directed straight outward; a few small setigerous punctures along style, chiefly on outer portion. Phallosome a small oval glabrous plate. Aedeagus elongate, slender, subequal in length to the basal dististyle.

HABITAT: Mexico (Guanajuato). *Holotype*, ♂, Irapuato, altitude 5820 feet, November 11, 1927 (Dampf); M. F. 1311.

Molophilus (***Molophilus***) ***telerhabda*** is very different from all other regional species of the genus, being most similar to species such as ***M.*** (***M.***) ***ductilis*** Alexander, yet quite distinct in the structure of the male hypopygium, especially the basal dististyle.

BOOK NOTICES

INSECT MICROBIOLOGY, by EDWARD A. STEINHAUS. Pages x+763, 1946. Comstock Publishing Company. Price $7.75.

The publication of this book is a milestone in the scientific comprehension of the relations between the multitude of insects and microorganisms. As far as the reviewer knows, no such treatment of the subject has yet appeared, even in shorter form. It will undoubtedly be a blessing to the scientists who have need of a compact survey of this rapidly expanding field of knowledge.

As Dr. Steinhaus notes in his preface, the recent war, conducted in many parts of the world with varied climates, gave America greater consciousness of the role of insects in the transmission of diseases of man, animals and plants. He deplores the situation faced at the time, with established knowledge widely scattered and unorganized, and offers his book as a more compact treatment, necessarily abridged in detail although comprehensive in scope. He treats both insects and the related mites and ticks in their relations with all significant microorganisms: bacteria, protozoa, yeasts, fungi, rickettsiae, spirochaetes and viruses. In launching this pioneer volume he warns reviewers that errors may be expected, but evidently he has made every possible effort to keep his statements in harmony with the findings of specialists and this reviewer, for one, does not care to seek minor errors in a work of such obvious value. An author is not to be condemned for errors in a work of extensive correlation as he might be for errors in his own specialty.

Following a brief introduction the book contains twelve chapters on Extracellular Bacteria and Insects, Specific Bacteria Associated with Insects, Intracellular Bacteriumlike and Rickettsialike Symbiotes, Rickettsiae, Yeasts and Insects, Fungi and Insects, Viruses and Insects, Spirochaetes Associated with Insects and Ticks, Protozoa and Insects (Except Termites), Protozoa in Termites, Immunity in Insects and Methods of Procedure. Thus the treatment is broadly biological and the book is of interest not only to medical entomologists but to plant pathologists, bacteriologists, apiarists and biologists in general.

It is impossible in the usual scope of book notices in the ANNALS to treat a volume of this size in great detail, but as examples of the judicious organization of the book two chapters are excellent. In his treatment of specific bacteria the author clarifies his use of the nomenclature and then, following Bergey's *Manual of Determinative Bacteriology*, tabulates the classification and records with brief notes on culturing, staining and host relations of each species known to be associated with insects. This catalogue covers fifty pages. In the chapter on viruses the treatment is in three divisions covering, respectively, virus diseases of insects, vectors of pathogenic viruses of man, animals and plants, and finally bacteriophage, of which little information is to be had. Elsewhere the arrangement of materials is equally convenient for reference.

Eighty-nine pages of references are evidence of the enormous amount of material covered in the preparation of the book. Ample author and subject indices fill the last seventy-one pages.

Paper and printing remind us that the war is over, and with it the unattractive economies to which publishers were forced. The two hundred fifty text figures are not uniformly good, but none is open to serious criticism.

In our age of specialization, with vast detailed knowledge being recorded day by day, vision and comprehension and a measure of temerity are necessary for a scientist to launch upon a project of this kind. But as each of us must specialize if sound research is to continue, so must each of us retain some appreciation of broader fields about him if he is not to become hopelessly narrow. And our detailed discoveries can attain their greatest value to mankind only if someone will leave his laboratory now and then to lay them into a significant mosaic. For this reason we should be grateful to authors who have the vision and comprehension shown by Dr. Steinhaus in preparing this book, and the temerity to risk those critical reviews which seek out the inevitable errors!—A. W. L.

CHECKLIST OF THE COLEOPTEROUS INSECTS OF MEXICO, CENTRAL AMERICA, THE WEST INDIES AND SOUTH AMERICA, PART IV, by RICHARD E. BLACKWELDER. Pages iii+551 to 763, 1946. United States National Museum Bulletin 185. For sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Price 50 cents.

The fourth part of Blackwelder's tremendous compilation continues the checklist of the Polyphaga, covering the families Cerambycidae, Chrysomelidae and Brucidae.

With the appearance of part four this great undertaking approaches completion, with only six families of the classification as outlined in the introduction yet to be covered. One can well imagine that Dr. Blackwelder will find relief as well as satisfaction in its consummation and can only hope that the monotony of such a task will be rewarded by an adequate realization of the service rendered to taxonomists in this largest of insect orders.—A. W. L.

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A NEW SPECIES OF FLEA FROM THE FIELD MOUSE, BAIOMYS TAYLORI

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A large series of an apparently new flea has been taken from the field mouse, *Baiomys taylori*, in Lavaca County, Texas, in connection with an extensive murine typhus research program being conducted there by the Texas State Department of Health and the United States Public Health Service. Considering the small size of the *Baiomys*, the mice were heavily infested with this flea. During March and April, 1946, eighty-one fleas were combed from twenty-one of these mice.

This new flea has been identified according to Ewing and Fox (2) as a member of the genus *Trichopsylla*, subgenus *Pleochaetis*. Augustson (1) recently described a new species of flea from *Peromyscus* mice taken at San Antonio, Texas, with similar generic characters to the species described in this paper. He erected the new genus *Pleochaetoides* to hold his species, *Pleochaetoides bullisi*. However, Ewing and Fox are followed here.

Dr. C. F. W. Muesebeck of the United States National Museum and Captain Robert Traub, Sn. C., made many helpful suggestions in the preparation of this paper. The flea is named for Dr. J. V. Irons, Associate Director of Laboratories, Texas State Department of Health.

Family **Dolichopsyllidae**

Trichopsylla (Pleochaetis) ironsi n. sp.

Holotype Male.—*Head* (fig. 1): Frontal tubercle small; three rows of preantennal bristles, the first of eleven bristles of varying size, becoming an irregular row near the antenna (this number varies from nine to twelve in the paratype males), the second row of four large bristles with five very small bristles interspersed, the third row of four large bristles and one very small one (in the paratype males there are sometimes only three large bristles); eight very small delicate bristles on preantennal region of the head bordering the antennal groove (this number varies

considerably in the paratypes); eye small and not heavily pigmented; genal process sharply acuminate; labial palpi slightly shorter than fore coxa; postantennal region with three rows of bristles; the first consisting of four large bristles (only three in some paratypes), the second of five (four to seven in paratypes) and the third of six large bristles and three very small ones; a row of eight (varies considerably in paratypes) delicate bristles on postantennal region of the head paralleling the antennal groove; bristles on second segment of antenna reduced.

Thoracic and Abdominal Segments (figs. 2, 3, and 4).—Pronotal ctenidium of twenty slender spines; a single large antepygidial bristle present; tergite VIII enlarged; sternite X reduced to small flaps; sternite IX broad and not divided into lobes, a single large bristle anteriorly; sternite VIII consists chiefly of two large, membranous flaps; movable finger approximately three times as high as wide and bearing five spiniforms of varying thickness and length; clasper with two long acetabular bristles, a more delicate bristle present apically; penis long and slender; spring not quite completing one full turn.

Legs.—Tarsi V with five lateral plantar bristles, the first pair displaced medially; hind tarsi I not exceeding II and III together; outer surface of fore femur with several small setae.

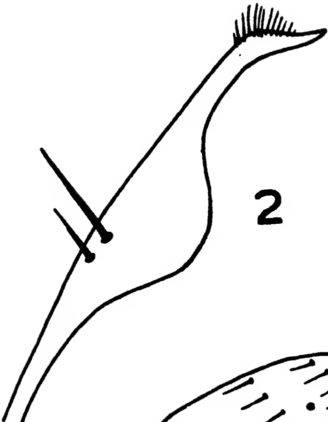
Allotype Female.—Head: Three rows of preántennal bristles present as in the holotype, first row six in number (varies in paratype females from six to eight), second row of four large bristles, third row of four large bristles (paratype females with three to five large bristles); on preantennal region of head bordering the antennal groove a row of six very delicate bristles; on postantennal region of head bordering antennal groove a row of eleven very delicate bristles, in addition to the three rows of stout bristles, the first of three (paratypes with three or four), the second of six (paratypes with four to seven), and the third of seven large bristles and four small ones.

Abdominal Segments (fig. 5): Three stout antepygidial bristles present, the inner member three times as long as the outer two; the spermatheca longer than wide, with arm of approximately the same length, arm about half as thick as the body; style long and slender, over twice as long as width at base, one lateral bristle present; sternite VII without a pronounced sinus.

Holotype.—A male collected by the writer from *Baiomys taylori*, taken near Yoakum, Texas, March 21, 1946. Deposited in the collection of the Texas State Department of Health, Austin, Texas. *Allotype*.—A female collected with the holotype and also deposited in the collection of the Texas State Health Department, Austin, Texas. *Paratypes*.—Twenty specimens taken from six *Baiomys taylori* from Yoakum, Texas, March 19, 1946; eleven specimens from one *Baiomys*

EXPLANATION OF PLATE I

FIG. 1. *Trichopsylla (Pleochaetis) ironsi* Eads, head, holotype male. FIG. 2. *Trichopsylla (Pleochaetis) ironsi* Eads, sternite VIII, holotype male. FIG. 3. *Trichopsylla (Pleochaetis) ironsi* Eads, sternite IX, holotype male. FIG. 4. *Trichopsylla (Pleochaetis) ironsi* Eads, finger, clasper, holotype male. FIG. 5. *Trichopsylla (Pleochaetis) ironsi* Eads, spermatheca and sternite VII, allotype female.



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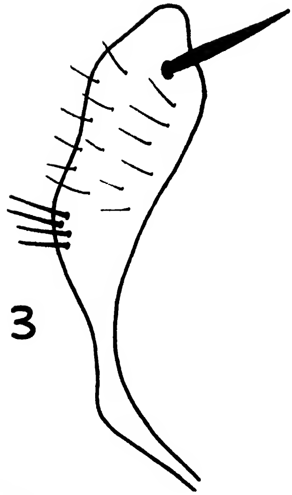

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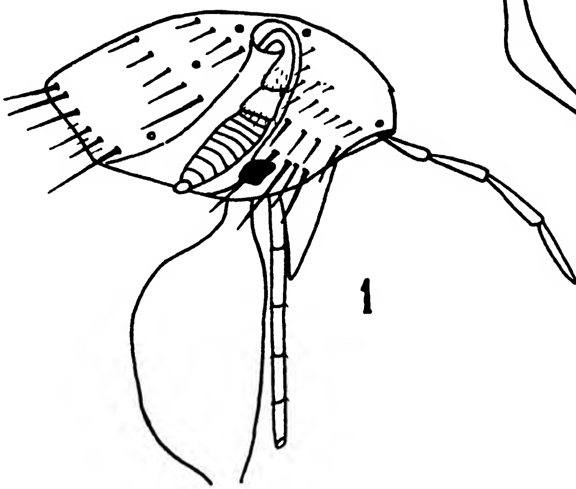

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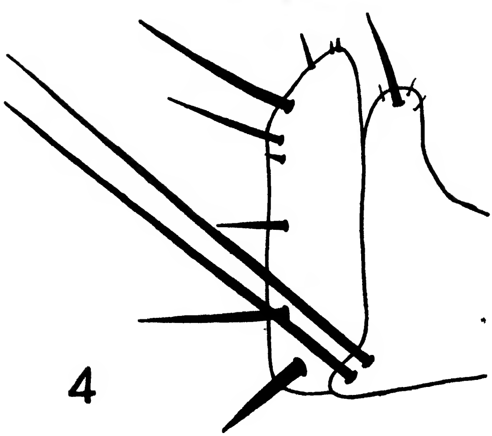

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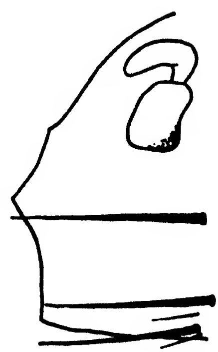

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taylori from Yoakum, Texas, March 21, 1946; thirteen specimens taken from three *Baiomys taylori* from Yoakum, Texas, April 17, 1946; fourteen specimens taken from three *Baiomys taylori* from Yoakum, Texas, April 18, 1946; three males and three females were sent to the U. S. National Museum; five specimens from four *Baiomys taylori* from Hallettsville, Texas, April 18, 1946. All paratypes were collected by the writer.

Type host.—*Baiomys taylori.*

Type locality.—Yoakum, Texas.

This new species is related to *Pleochaetoides bullisi* Augustson both as to type of host and general chaetotaxy. However, the modified segments of the male are sufficiently different to render separation easy. *P. bullisi* females are not known.

The host determination is by Dr. W. B. Davis, Head of the Fish and Game Department, Texas A. & M. College, College Station, Texas.

REFERENCES

1. **Auguston, G. F.** 1944. "A New Mouse Flea, *Pleochaetoides Bullisi*, N. Gen., N. Sp., From Texas." The Journal of Parasitology, Vol. 30, No. 6.
2. **Ewing, H. E.**, and **Fox, I.** 1943. "The Fleas of North America." U. S. Department of Agriculture, Misc. Pub. 500; 1–143.

THE MOSQUITOES OF THE SOUTHERN UNITED STATES EAST OF OKLAHOMA AND TEXAS, by STANLEY J. CARPENTER, WOODROW W. MIDDLEKAUF, AND ROY W. CHAMBERLAIN. Published by the American Midland Naturalist, The University Press, Notre Dame, Indiana. Monograph Series No. 5; 292 pages, 155 figures. Price $4.00.

Regardless of what page you happen to see first in this book, the chances are excellent that you will have a very favorable reaction. It is uniformly of high quality and this is due to careful preparation of subject matter by the authors, fine illustrations by a competent artist, and good editing, printing, and binding.

This study is one of the most thorough faunistic accounts of mosquitoes in any geographic subdivision of considerable size in the United States. A total of 71 species and subspecies is recorded and one is inclined to predict that for indigenous species the record is now complete; that additional species will be introduced has already been proven in current literature.

Each species is uniformly treated under headings of adult female, adult male, fourth instar larva, distribution based on the authors' records and from other areas based on literature, bionomics, and medical or public health significance if any. There are keys to adult females, male terminalia, and fourth instar larvae. The illustrations by Mrs. Elizabeth Kaston are worthy of special report because of their accuracy and beautiful appearance. Illustrations of larvae and male terminalia are regularly given and valuable diagnostic features of certain species such as the egg, wing, leg, mesonotum, and abdomen are included.

In addition to this material, which covers 231 pages, are carefully prepared chapters on technique and identification, a bibliography of 188 references, and an index.

Although this book will be much used as a manual for information, particularly identification, its most valuable function will be as a stimulus to further research. The authors have written so as not to hide gaps in our knowledge; any competent reader can easily discover many problems that can be solved.

—C. E. VENARD.

BIOLOGIES OF TWO MALARIA MOSQUITOES IN NEW GUINEA[1]

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Among the more important mosquitoes affecting the health of native and newcomer alike in New Guinea and adjacent islands are *Anopheles punctulatus* Dön. and *A. farauti* Lav.[2] They are the principal vectors of malaria over most of this wide range. In addition they are possible vectors of human filariasis in parts of these areas. Their extensive distribution and ready adaptation to conditions incident to waging the recent war increased their importance to armies in the field and in camp. Observations reported herein were made during 1943 and 1944 in eastern and northern Papua and on Biak, one of the principal islands of the Schouten Group in the Netherlands East Indies.[3]

RANGE

Both *Anopheles punctulatus* and *A. farauti* have been collected widely over New Guinea, New Britain, New Ireland, the Solomon Islands and the New Hebrides according to Taylor 1930, 1934, 1942, Hérivaux et al. 1939, Lever 1942, Huisman 1929, Walch 1932, Holland 1933, Belkin et al. 1945 and numerous observers in malaria survey units both U. S. and Australian. Most of these observers in published general observations on environmental relationships agree that preferred larval sites are exposed to sunlight.

Unpublished reports from observers in the Australian army show certain geographic limitations to distribution of these species in New Guinea. Lieutenant R. F. Landon collected up the Lakekamo River valley, over the Owen Stanley Range and down the Markham River Valley to the north coast of New Guinea. He found *A. punctulatus* to be scarce and *A. farauti* to be abundant in the coastal strip of kunai (tall grass) flats and savannah forest near the mouth of the river. Ten to 20 miles inland he found the two species to be nearly equally abundant. At Bulldog, some 30 miles inland, the former species was dominant. Higher in the mountains neither was found. On the north side at Wau, elevation 3500–3800 feet, *Anopheles punctulatus* was present.

[1]Research Paper No. 817, Journal Series, University of Arkansas. Approved for publication by the Director of the Arkansas Agricultural Experiment Station.

[2]Formerly known as *A. punctulatus moluccensis* (Sw. and Sw. de G.). The synonymy of this species has been discussed by Knight and Farner (1944).

[3]Authors and assistants were members of the 17th Malaria Survey Detachment, Army of the United States, at the time these observations were made. Illustrations from photographs made by 4th Medical Detachment Museum and Medical Art Service, Army of the United States.

Captain H. A. Malcolm reported *A. punctulatus* dominant at an altitude of 1500 feet some 20 miles northeast of Port Moresby.

HABITAT

In a general way soil type is important as a factor affecting abundance of these mosquitoes. *Anopheles punctulatus* is dominant where the soil is heavy clay, and *A. farauti* replaces it where the soil is sand or muck. Where the soils intergrade the species are both present. The sandy coastal strip north of Oro Bay has only *A. farauti* as is shown in Table I, but around Milne Bay the shores are clay divides and sandy

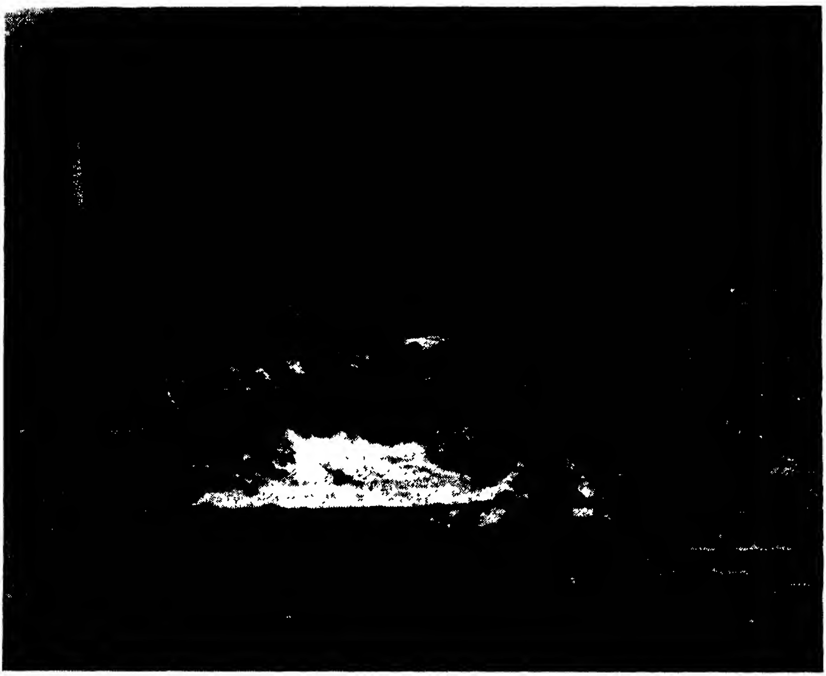

FIG. 1. Man-made larval site for *Anopheles punctulatus*. Oro Bay, New Guinea.

deltas, and both species are present. In the foothills west of Oro Bay the sand is replaced by clay and *A. punctulatus* is dominant. Pools in the red clay soil of Biak are sources of *A. punctulatus* to the exclusion of the other. A few muck beds and tidal pools provide a limited source of *A. farauti* on this island.

Larvae of both species develop in ground pools largely. *A. punctulatus* larvae were most abundant in sunlit depressions such as tracks of animals, man and vehicles (Table I). Under plantation conditions tracks of pigs, cattle, man and carts provided numerous larval sites. When any camps were constructed many more favorable sites were created by trucks, (fig. 1) construction machinery and excavations.

Additional natural larval sites included pools with flotage (fig. 2), pools with filamentous algae, bomb craters, hog wallows, intermittent streams, grassy pools and ditches. Rarely have larvae been taken from mangrove swamps, sago swamps, tin cans and brackish water. No larvae were collected from tree holes, coconuts, foul water or discarded paper cartons or wooden amunition boxes although representative samples of water were examined.

Larvae of *A. farauti* were found most often in sunlit depressions such as shallow pools especially in those with floating sticks (fig. 3) or vegetation (Table I). Tracks of all sorts were important sources also. Grassy margins of sluggish streams were common larval sites, but no larvae have been observed in grassy margins of fast flowing streams. Larvae have been collected in partially shaded portions of mangrove

TABLE I

RELATIVE IMPORTANCE OF LARVAL HABITATS OF *Anopheles punctulatus* AND *Anopheles farauti*, NEW GUINEA, 1943 AND 1944

HABITAT	LARVAE IN 100 DIPS			
	Milne Bay (North Shore)		Oro Bay (Coastal Strip)	
	A. punctulatus	*A. farauti*	*A. punctulatus*	*A. farauti*
	Number	*Number*	*Number*	*Number*
Wheel ruts	26	8	0	35
Pools (surface free)	18	7	0	37
Pools (floatage)	13	11	0	54
Pools grassy	3	4	0	24
Stream margins	2	10	0	5
Mangrove	6	0	0	9
Sago	1	1	0	2
Metal containers	0	0	0	1

swamps subject to only slight tidal fluctuation, and were especially likely to be present if flotage was abundant. Sago swamps, metal containers and lakes were of little importance as sources of this species, and no larvae were collected in tree holes, coconuts, foul water or empty cartons although representative samples of water were examined.

Observations outlined above on relative importance of certain environments as sources of both species are based on data obtained by dipping in Milne Bay and Oro Bay areas. Using white enamel dippers as sampling devices, 46,074 records were obtained from all sorts of representative habitats. In Table I are shown summaries of collections from the more abundant potential larval sites.

LIFE HISTORY

General.—Life histories of *A. punctulatus* and *A. farauti* are similar in general to those of other species in the genus. The tiny black eggs

supported by two lateral floats rest horizontally in a meniscus along some floating or emergent object during incubation. After a variable incubation period, a larva hatches by pushing off the anterior end of the egg and wriggling free. Larvae first skim about vigorously over the surface before they come to rest in a horizontal position in a meniscus adjacent to some object. In water lacking flotage or emergent objects, larvae feed in open water where they are more restless than otherwise. In order to feed, a larva rotates its head so that the mouth bristles may vibrate in the surface film where a current toward the mouth is created. Food consisting of minute floating particles and possibly micro-organisms drifts with the current toward the mouth. Rate of development

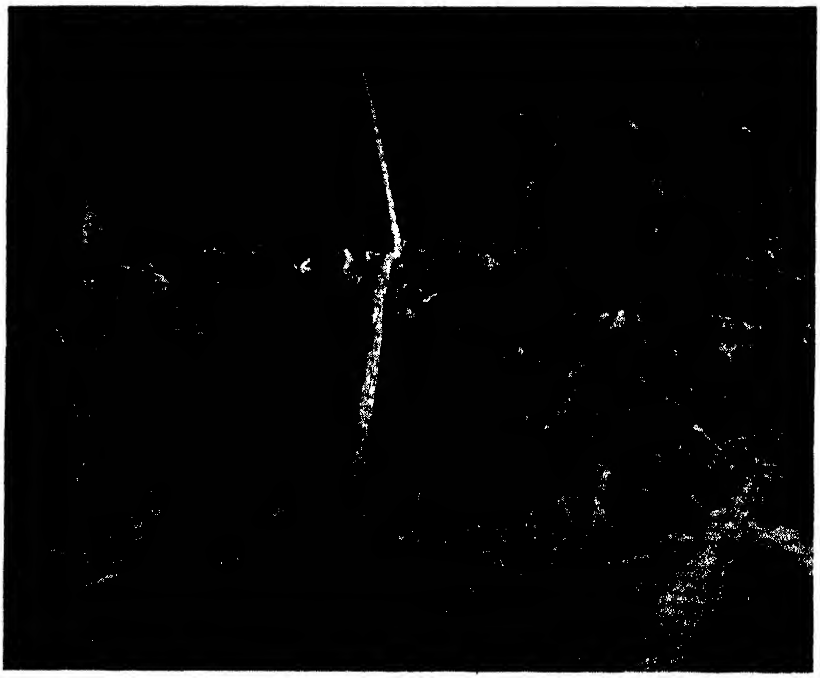

FIG. 2. Natural larval site for *Anopheles punctulatus*. Oro Bay, New Guinea.

is rapid when food is abundant so that a larva may pass the four instars within a week or so. The pupal stage is completed in a day of two. Adults leave the larval site at night and possibly on dark days during which time they mate and seek blood. Oviposition occurs a week or so after emergence. Under favorable conditions females may live several weeks in summer. More specific details regarding development of the two species follow.

Egg Stage.—Eggs of both species are jet black, very slightly crescentic with two prominent lateral floats. In a natural environment they are difficult to find because they rest high in a meniscus against

a floating object or margin of a pool. Many cling to surfaces where they were left by receding water. Incubation required from two to six days for both species (Tables II and III) in the laboratory where the eggs were kept floating. The mean incubation for *A. punctulatus* was 2.5 days as against 3.5 days for *A. farauti* under these conditions. Eggs resting on moist surfaces incubated at the normal rate but did not hatch until floated. In the laboratory eggs resting on a moist surface remained viable as long as 14 days after being deposited. Viable eggs so treated normally hatched within a few minutes after flotation. Unti, 1943, reported from South America that eggs of *Anopheles albitarsis* Arrib., *A. argyritarsis* R-D, *A. pessoai* Galvão and Lane, *A. noroestensis*

FIG. 3. Natural larval site for *Anopheles farauti*. Oro Bay, New Guinea.

Galvão and Lane, and *A. strodei* Root would remain viable on moist paper 15 days during winter.

Larval Stage.—Larvae of these two species represent extremes in relative activity. *A. punctulatus* larvae were observed to be restless, seldom remaining in one place more than a few minutes, except as prepupae and before each molt. Examination of living larvae under a microscope usually required several minutes each because they moved so often. Larvae of *A. farauti* on the other hand move little except when disturbed. Normally they rest close against some object or bank where they may remain for hours. Examination of living larvae of this latter species is facilitated considerably by this habit.

Differences in activity of the two species is also related to differences in rates of growth as is shown in Tables II and III. Larvae of both species were reared in the laboratory in petri dishes under comparable conditions. Yeast moistened to form a paste was fed to the larvae on pieces of rock barely submerged. Larvae of the same age and species were kept as the same lot in one dish. Each day all lots were examined and larvae that had molted were removed to other dishes. Under these conditions *A. punctulatus* completed four instars in six to 11 days or in a mean of 7.5 days while *A. farauti* required seven to 18 days or a mean of 11.3 days. Each instar of the latter species required about a day longer on the average than was true for *A. punctulatus* as is shown in Tables II and III.

Pupal Stage.—The pupal stage requires about one day for completion for both species, but *A. farauti* takes a little longer as is shown in Tables II and III.

TABLE II

DURATION OF IMMATURE STAGES OF *Anopheles punctulatus* IN LABORATORY, ORO BAY, 1944

STAGE	NUMBER	DURATION		
		Maximum	Minimum	Mean
		Days	*Days*	*Days*
Egg	429	6	2	2.56 ± 0.05*
First larval instar	385	4	1	2.02 ± 0.05
Second larval instar	339	3	1	1.47 ± 0.02
Third larval instar	315	3	1	1.50 ± 0.03
Fourth larval instar	238	3	1	2.45 ± 0.03
Pupa	238	2	1	1.00 ± 0.01
Larva and pupa	225	12	7	8.44 ± 0.05

*Standard error.

TABLE III

DURATION OF IMMATURE STAGES OF *Anopheles farauti* IN LABORATORY, ORO BAY, 1944

STAGE	NUMBER	DURATION		
		Maximum	Minimum	Mean
		Days	*Days*	*Days*
Egg	398	6	2	3.53 ± 0.05*
First larval instar	174	7	1	3.21 ± 0.05
Second larval instar	174	5	1	2.51 ± 0.07
Third larval instar	174	6	1	2.26 ± 0.03
Fourth larval instar	174	8	2	3.33 ± 0.09
Pupa	174	3	1	1.21 ± 0.01
Pupa and larva	173	19	9	12.57 ± 0.24

*Standard error.

Larval development of both species varies according to relative exposure of developmental site to the sun under natural conditions. In exposed sites where water temperature was often 95 degrees F. and more, larvae of *A. punctulatus* have been observed pupating on the fifth day after hatching. Shaded pools and all pools in prolonged cloudy weather are much cooler than those exposed to direct sun, and larvae in them may not mature in less than two weeks after hatching.

Relation to Control.—Differences in duration of aquatic stages of the two species are significant in planning control operations for an area like an army base. Since *A. punctulatus* may develop from hatching to emer-

FIG. 4. Natural resting site for adult *Anopheles punctulatus*. Bank of Embogo River, Oro Bay, New Guinea.

gence in six days under favorable conditions in the field, oiling operations must be repeated at least every five days to insure adequate coverage. In practice oiling was carried out twice each week. In locations where *A. farauti* is the only species present as was the case north of Oro Bay, oiling operations carried out once each week assured adequate timing.

Adult Stage.—Adults of *A. punctulatus* were collected consistently and in numbers in their resting places, but dependable collecting places for *A. farauti* were not found. The former may be collected along moist banks near sources of blood. Such a site shown in fig. 4 is a bank

of the Embogo River at Hanagela village in the foothills near Oro Bay. At the time observations were made this bank was about six feet high, was nearly vertical, was pitted with shallow cavities and the face was not exposed to direct sun. Very little grass or debris was present. Although the bank was much the same for about 50 yards, nearly all adults were present along that part shown in fig. 4. Directly above this site natives sat on the ground and daily worked at certain chores during the interval in which observations were being made. Thus it seems that banks near soil bearing fresh body odor is attractive for resting sites. This is indicated at another resting site on a narrow stretch of a low bank (two feet high) obscured by overhanging grass in heavy shade near Kieta Creek labor camp one mile north of the location described above. A frequently used native trail passed along the bank directly above the collecting site. No mosquitoes were to be collected beyond the point where the trail veered away from the bank. A third collecting site at Milne Bay was a bank with overhanging grass within a few feet of a frequently used native trail and near a small village. Both males and females were collected at these sites, and the females had probably fed the night before collection as all contained fresh blood. Dissections and also observations on oviposition showed these to be newly emerged females. *A. farauti* adults were collected at the Kieta Creek site described above, but observations were too limited to show this is a typical site. Unfortunately no comparable sites were known in areas where larvae of this species were abundant.

The limit of effective range of flight for adults of *A. punctulatus* was observed for one area near Oro Bay. This experiment was carried out in the narrow valley of the Embogo River above and below Hanagela village. The lower end of the area includes a part of a coconut and rubber plantation, and the upper part is compressed to a narrow ravine between steep hills. This area lay outside the boundary of a large army base and had remained much the same as it was pre-war, and no mosquito control had been practiced at any time.

This experiment was based on the reduction of adult abundance by progressive elimination of larvae about a central point. Preliminary observations included (1) determination of adult abundance and (2) location of all larval sources. In order to determine natural abundance of adults, all mosquitoes on a 50-foot section of the river bank at Hanagela were collected daily for eight days before treatment began. These were always newly emerged mosquitoes and represented new arrivals from larval sites. Daily collections of adults continued of course until the end of the experiment. Larval sites were located and indicated on a large scale map. Larval elimination was accomplished by applications of No. 2 diesel oil sprayed from knapsack sprayers by native labor under direct supervision of trained enlisted technicians. Each pool sprayed was checked on a map as it was sprayed. Other crews of observers with dippers followed spraying crews and searched for inadequately oiled sites. All sites not properly covered were sprayed immediately. All area within a radius of one-quarter mile was thus oiled twice and checked twice at the beginning of the experiment. Effect of this treatment was determined by the daily collections made during the eight-day interval beginning one week after the first spraying

was completed. At the end of this interval all larval sites within a radius of three-quarters mile were treated and checked in the manner described for those within one-quarter mile radius. One week after this area had been covered, daily counts for another eight days were made to determine the adult abundance.

The effect of progressive elimination of larvae about a central point on adult abundance is shown in Table IV. Before treatment average daily collections of females and males was 29 and 36 respectively at a centrally located collecting site. After oiling all larval sites within one-quarter mile radius, average daily collections of females and males was 24 and 19 respectively. Obviously little change in adult incidence was brought about by destruction of larvae in such a small area. Extension of the treated area to three-quarters mile radius reduced females and males to an average daily catch of one and three respectively. The female population was reduced nearly 97 per cent, a figure well within limits of practical control.

TABLE IV

EFFECT OF PROGRESSIVE ELIMINATION OF LARVAL DEVELOPMENT ON ABUNDANCE OF ADULT *Anopheles punctulatus*, HANAGELA, ORO BAY, MAY AND JUNE, 1944

INTERVAL	DAILY COLLECTIONS					
	FEMALES			MALES		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
	No.	*No.*	*No.*	*No.*	*No.*	*No.*
Before treatment.....	36	16	29	63	15	36
8–15 days after treating one-fourth mile	37	11	24	29	10	19
8–15 days after treating three-fourths mile..............	4	0	1	8	0	3

Adult collections were continued six weeks after the last application of oil in order to determine the time required for adult incidence to return to normal. During the first two weeks adult collections were consistently low, but by the sixth week average daily collections were approximately the same as they were before the experiment began.

Data on the longevity of adults are inconclusive because those reared in the laboratory could not be induced to oviposit dependably. Some lived 35 days and fed often while others died in a few days without feeding. Newly emerged and engorged females collected in the field died following oviposition because subsequent blood meals were denied them.

Both species have similar oviposition habits according to observations on wild engorged females in cages. Eggs were laid on moist surfaces as readily as on water. Caged mosquitoes provided with bowls

lined with moist filter paper and others partly filled with water laid eggs in about equal numbers in each. For instance, females of *A. punctulatus* in one cage laid 847 eggs on moist paper and 799 eggs in a bowl containing water. Many of the eggs in the bowl containing water were deposited well above the water on the paper-lined sides. Superficial field observations indicate that such is the case under natural conditions. For example at Milne Bay in 1943 and on Biak in 1944, larvae of *A. punctulatus* in the fourth instar were found in wheel ruts on the fourth day after daily observation from the time of flooding. As has been shown in another part of this paper, eggs require an average of 2.5 days for incubation, therefore they must have been present prior to flooding.

DISEASE RELATIONS

Both *A. punctulatus* and *A. farauti* are recognized as important vectors of malaria in New Guinea. Opportunity to observe the extent

TABLE V

INCIDENCE OF PLASMODIUM OCCYSTS IN NATURALLY INFECTED *Anopheles punctulatus* AND *Anopheles farauti*, HANAGELA VILLAGE, ORO BAY, NEW GUINEA, 1944

Date of Collection	Stomachs Examined		Stomachs Infected		Infection Rates	
	punctulatus	*farauti*	*punctulatus*	*farauti*	*punctulatus*	*farauti*
	No.	*No.*	*No.*	*No.*	*Percent*	*Percent*
25 April–23 May	217*	0	11	....	5.1	....
24 May–28 May	80	27	6	2	7.5	7.3
29 May–4 June	0	29	....	0	....	0.0
6 June–21 July	117†	76	3	3	2.5	3.9
Total	414	132	20	5	4.8	3.8

*Glands were infected in two specimens.
†Glands were infected in one specimen.

of infection in these two mosquitoes was provided when numbers of them were collected at Hanagela and Kieta Creek, two villages where malaria was prevalent. Females were collected on banks in the interval between 25 April and 21 July, 1944. Previous observations showed that adults taken at these sites were newly emerged and possibly had taken no more than one blood meal. They were kept alive six days in the laboratory by feeding them juice of boiled raisins. Dissections were made in the usual manner extracting first the gut, then the glands. Examinations of 414 *A. punctulatus* showed 20 with oocysts on the stomachs which was an average of 4.8 per cent infected as shown in Table V. Incidentally three of these showed sporozoites in the salivary glands. Examinations of 132 *A. farauti* showed five with oocysts which was an average of 3.8 per cent infected, but none showed sporozoites.

The low sporozoite count may be attributed to the fact these mosquitoes possibly had had no more than one blood meal, and usually that had been taken the night before capture. Further evidence that specimens were recently emerged at the time of collection is shown by dissections of 294 *A. punctulatus* made during first three days after capture where only four bore oocysts large enough to distinguish. The average number of oocysts on the guts of infected *A. punctulatus* and *A. farauti* were six and four respectively. One *A. punctulatus* bore as many as 30 oocysts on the stomach wall.

In addition to malaria parasites, unidentified filarid larvae were found in both species. In the thoracic cavities of 414 *A. punctulatus*, they were found in 16 or 3.8 per cent. In 132 *A. farauti*, they were found in three or 2.3 per cent. These filarid larvae are presumed to be those of *Wuchereria sp.*

SUMMARY

1. Malaria, one of the worst hazards to be encountered by native and newcomer alike in New Guinea, is transmitted by *A. punctulatus* Dön., *A. farauti* Lav. or both. The former species was found most abundant wherever clay soil is found whether at sea level or inland. It has been reported to occur as high as 3500 feet in the mountains. The latter was present on the coastal plains where sand and muck are present.

2. Larvae of both species are present in collections of water in all sorts of tracks and are especially abundant in clearings incident to construction of army camps. Natural pools and grassy margins of sluggish streams are choice sites for larvae of *A. farauti*.

3. Differences exist in rates of development of the two species. Consistently *A. punctulatus* develops more rapidly requiring on the average one day less for the egg stage and each larval instar. In the laboratory the average time required for the aquatic interval was 8.5 days for *A. punctulatus* and 12.5 days for *A. farauti*. In the field under very favorable conditions the former may complete larval and pupal periods in five or six days.

4. Eggs of both species may be deposited on moist surfaces or water, and in the former case they may remain viable for at least 14 days.

5. Adults of these species were collected on moist banks near village sites. *A. punctulatus* has been most commonly collected on vertical banks out of direct sunlight within a few feet of a frequently used trail or place where natives sit on the ground to work.

6. The limit of effective flight range of *A. punctulatus* was three-quarters mile as determined by larval elimination in a native area near Oro Bay. After oiling an area within a radius of three-quarters mile, females at a central collecting site were reduced to about three per cent of the number before treatment.

7. A population of *A. punctulatus* at an adult collecting site returned to normal within six weeks after larvae were eliminated in an area within a radius of three-quarters mile.

8. Both species are recognized as important vectors of malaria. Examination of stomachs of 414 *A. punctulatus* females fed once in the

wild showed 20 or an average of 4.8 per cent with oocysts. Three had sporozoites in the salivary glands. Examination of stomachs of 132 *A. farauti* showed five or 3.8 per cent with oocysts.

9. Unidentified filarid larvae presumed to be ***Wuchereria sp.*** were found in both species. Infection of *A. **punctulatus*** was 3.8 per cent and 2.3 per cent for *A. farauti.*

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CATALOGO DE LOS INSECTOS QUE ATACAN A LAS PLANTAS ECONOMICAS DE CUBA, by S. C. Bruner, L. C. Scaramuzza and A. R. Otero. 246 pages, 12 plates. Bulletin No. 63 of the Estacion Experimental Agronomica, Santiago de las Vegas. Published by the Ministerio de Agricultura, September, 1945.

The arrangement of this catalog is admirable. In the body of the book plant genera are entered in bold-face capitals, alphabetically arranged. Under each genus the species considered are made conspicuous by bold-face type, and under the species the insects attacking them are also in bold-face, arranged by orders with a center head in capitals where several species of the same order are included. The result is an exceedingly usable manual. Further, the index is conveniently divided into sections on insects and other arthropods, both arranged by orders, and on natural enemies and vernacular names of plants. The twelve excellent half-tone plates include seventy-six figures, mostly of adult insects of various orders. The wealth of information included, the excellent arrangement and the fine quality of the printing are a tribute to everyone concerned in the production of the bulletin.—A. W. L.

DESCRIPTION OF THE LARVA OF KEIFERIA PENICULO HEINRICH, WITH A KEY TO THE LARVAE OF RELATED SPECIES ATTACKING EGGPLANT, PEPPER, POTATO AND TOMATO IN THE UNITED STATES

(Lepidoptera: Gelechiidae)

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In the course of the special survey which the Bureau of Entomology and Plant Quarantine conducted in 1944–45 in the vicinity of ports of entry, larvae of a new gelechiid were frequently found feeding on eggplant. Adults were reared by members of the survey staff, and the species has been recently described as *Keiferia peniculo* by Heinrich.[1]

All the species treated here have the normal family characters, viz.: Anterior seta A^3 of the head remote from lateral seta L^1, as near or nearer to A^2 than to L^1. Prespiracular group of prothorax trisetose. Group VII of first abdominal segment bisetose. Abdominal proleg-bearing segments with seta IV approximate to V below the spiracale; group VII trisetose. Paired setae II of the ninth segment not on a single pinaculum. Seta I of ninth segment little, if any, closer to seta III than to seta II; each on a separate pinaculum. The following description of the larva of *peniculo* and key are submitted to assist field workers in recognizing it and the various associated species of *Keiferia* and *Gnorimoschema.*

Keiferia peniculo Heinrich

Mature larva 7–7.5 mm. in length.

Head flattened, slightly broader than high, pale yellow with a broad, dark, fuscous lateral band extending from incision of posterior margin into ocellar area and with intensity of the pigmentation often reduced beyond seta O^2. Dark pigmented spots present under ocelli. Frons approximately one-half height of epicranium; seta Adf^1 from middle or slightly above middle, with Adf^2 approximate and closer to Adf^1 than to apex of frons. Posterior seta P^1 laterad of Adf^1 and but slightly more distant than Adf^2 is from Adf^1; P^2 remote from and only slightly above level of P^1. Anterior seta of ultra-posterior group (X) approximate to and directly above P^2. Anterior setae A^1, A^2, and A^3 forming an obtuse angle, with setae A^1 and A^3 about equally distant from A^2. Seta L^1 remote from A^3 and approximately on level of P^1. Ocellar setae O^1 and O^2 approximate to ocelli I and III, respectively; line joining bases of setae L^1 and O^2 distinctly posterior to margin of ocellus I; seta O^3 remote from and slightly below level of ocellus VI.

[1]Heinrich, Proc. Ent. Soc. Wash. 48 (2): 35–36, 1946.

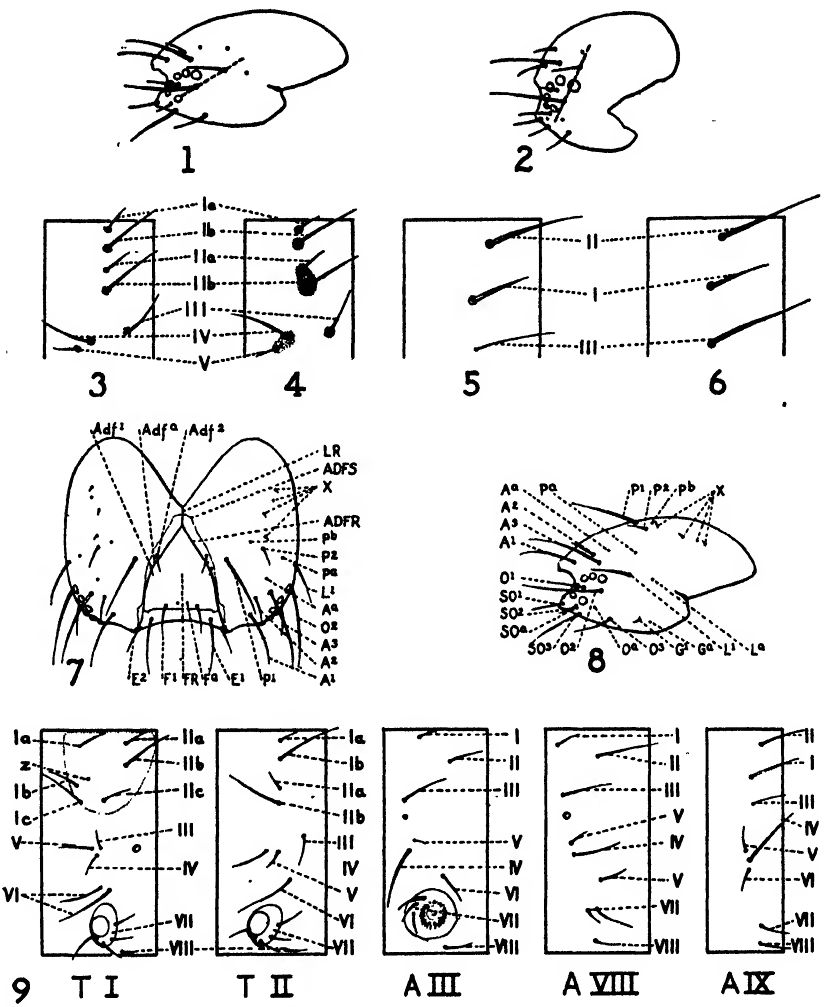

FIG. 1. Lateral aspect of head capsule of *Keiferia peniculo* indicating relative position of setae L¹ and O² to ocellus I. FIG. 2. Same of *Gnorimoschema gudmannella*. FIG. 3. Portion of mesothoracic segment with setae IIa and IIb on separate plates (semi-diagrammatic). FIG. 4. Same with IIa and IIb on a single fused plate. FIG. 5. Portion of ninth abdominal segment with seta III modified (semi-diagrammatic). FIG. 6. Same with seta III normal. FIG. 7. Dorsal view of head capsule of *Keiferia peniculo*. FIG. 8. Lateral view of head capsule of *Keiferia peniculo*. FIG. 9. Setal map of body segments of *Keiferia peniculo*.

Drawings prepared by Arthur D. Cushman, of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

Prothoracic shield uniformly pale yellowish amber, or with a posterior fuscous pigmentation which is broader and more intense middorsally. Thoracic legs sordid white, concolorous with the body. Crochets on abdominal prolegs 20–25, biordinal, arranged in a circle which is weaker outwardly and occasionally slightly broken. Ninth abdominal segment with seta III modified (slenderer than I or II); setae IV, V, and VI approximately in line.

Superficially resembling *K. lycopersicella* and *K. glochinella*, but the former has the thoracic legs darkly pigmented, and the latter has seta III of the ninth abdominal segment normal (as strong as I or II).

KEY FOR SEPARATION OF GNORIMOSCHEMA AND KEIFERIA LARVAE ATTACKING EGGPLANT, PEPPER, POTATO, AND TOMATO IN THE UNITED STATES

1. Seta III on ninth abdominal segment normal, as strong as or stronger than seta I or II (fig. 6) 2
   Seta III on ninth abdominal segment modified,[3] weaker than seta I or II (fig. 5) 3
2. Head flattened, plates at bases of setae IIa and IIb on meso- and metathorax separate (fig. 3). (Eggplant) .... **Keiferia glochinella** (Zell.)
   Head rounded, not appreciably flattened; plates at bases of setae IIa and IIb on meso- and metathorax fused, forming a single plate (fig. 4). (Potato), **Gnorimoschema plaesiosema** (Turner)
3. Thoracic legs with brown or blackish pigmentation 4
   Thoracic legs pale, whitish, concolorous with body 5
4. Prothoracic shield pale, with a conspicuous dark fuscous shading along lateral and posterior margins. (Eggplant, potato, and tomato), **Keiferia lycopersicella** (Busck)
   Prothoracic shield uniformly brown or black. (Eggplant, potato, and tomato) .... **Gnorimoschema operculella** (Zell.)
5. Head flattened; line joining bases of setae L^1 and O^2 posterior to ocellus I (fig. 1). (Eggplant) .... **Keiferia peniculo** Heinrich
   Head rounded, not appreciably flattened; line joining bases of setae L^1 and O^2 tangent to or passing through ocellus I (fig. 2). (Pepper), **Gnorimoschema gudmannella** (Wlsm.)

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[3]Magnification required depends on size of the specimen. A satisfactory method is to place the larva in a Syracuse watch glass or a shallow dish containing 95-percent alcohol and examine under a wide field microscope with adequate illumination.

THE NATURALISTS' DIRECTORY, THIRTY-FOURTH EDITION. 204 pages. Published by the Cassino Press, Salem, Massachusetts, 1946. Price $3.00.

This latest edition of the scientists' old friend is in the old format, with stiff paper covers. Names are listed by states, as before, and an increased number of foreign countries are included following the section devoted to the United States. One section lists scientific periodicals and another museums of natural history, the latter listed by states. A short appendix contains unclassified names received too late for inclusion in the main part of the directory. The chief interests of collectors are noted, together with the usual information on their desire to buy, sell or exchange. A number of interesting advertisements of dealers and collectors appear in this edition.—A. W. L.

ADDITIONAL NOTES ON THE TABANIDAE OF PANAMA[1] (Diptera)

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In 1942 I listed (Ann. Ent. Soc. Amer., 35, No. 4, p. 471) the 89 species of Tabanidae then known from the Republic of Panama and the Canal Zone. Since that time a certain amount of additional material has accumulated which makes it seem advisable to publish the present additional note. Nine species are added to the Panama fauna, six of which are described as new, bringing the total species recorded to 98. The heretofore unknown males of several species are described, and additional material and extension of ranges of a number of hitherto poorly known species are recorded.

I am very much indebted for much of what is interesting in this material to Messrs. Philip S. Marucci and George L. Wood, of the Army School of Malariology, to Dr. Thomas G. Aitken and to Mr. C. M. Keenan, Assistant Sanitary Inspector, Panama Canal Department, and I hereby express my grateful acknowledgment of their invaluable cooperation.

Assipala tanycerus (Osten Sacken)

Chrysops tanycerus Osten Sacken, 1886, Biol. Cent. Amer., Dipt. I, pp. 46–47 (♀; Costa Rica). Kértesz, 1900, Cat. Tab., p. 12. Ricardo, 1901, Ann. Mag. Nat. Hist., Ser. 7, 8, pp. 310 and 313. Aldrich, 1905, Cat. Dipt. N. Amer. Ent., p. 198. Surcouf, 1921, Gen. Insec., Taban., p. 155. Hine, 1917, Trans. Amer. Ent. Soc., 43, p. 292 (♀; Peralta Station, Costa Rica). Kröber, 1925, Konowia, 4, pp. 217, 221, 238; 1930, Zool. Anz., 90, pp. 73–74, figs. 11–12 (♀; Higuito, San Mateo, Costa Rica); 1934, Rev. Ent., 4, 2, p. 229. Pechuman, 1937, Rev. Ent., 7, 2–3, p. 140.

Assipala tanycerus Philip, 1941, Canad. Ent., 73, p. 4 (January); 1941, Rev. Ent., 12, 3, pp. 470–473 (December).

A single female, El Volcan, Chiriqui Province, Panama, February 15, 1943, T. Aitken coll. This interesting species is the type of the genus, and has been hitherto known only from Costa Rica. It may be distinguished from all other species occurring in Panama by the greatly elongate antennae with the terminal segment not half as long as either of the two preceding segments. The wing pattern is not very *Chrysops*-like, consisting of an abbreviated cross-band and large separate apical spot, while the cross-veins and fork of the third vein are surrounded by dark clouds.

Chrysops scalaratus Bellardi

1859, Ditt. Mess., Pt. 1, p. 72, Pl. 2, fig. 19 (♀; Mexico). Osten Sacken, 1878, Cat. Dipt. N. Amer., p. 54. Kértesz, 1900, Cat. Taban., p. 11. Ricardo, 1901, Ann. Mag. Nat. Hist., Ser. 7, 8, pp. 299, 304 (♂, ♀; Mexico, Honduras,

[1]The cost of publication of this article is paid by the Gorgas Memorial Laboratory.—EDITOR.

Chile; = ? *lateralis* Wied.). Kröber, 1925, Konowia, 4, pp. 216, 227, 362–363, Pl. 1, fig. 16; Pl. 3 and Pl. 5 (Br. Honduras, Costa Rica, Guatemala); 1934, Rev. Ent., 4, 2, p. 229. Bequaert, 1938, Carnegie Inst. Washington, publ. 499, p. 226; 1940, Rev. Ent. 11, 1–2, p. 270.

Chrysops apicalis Bellardi, 1859, Ditt. Mess., pt. 1, p. 73 (♂, Mexico). Pechuman, 1939, Bull. Brooklyn Ent. Soc., 34, 5, p. 241 (=♂ of *scalaratus*).

Chrysops lateralis, Hine, 1925, Occ. Pap. Mus. Zool. Univ. Michigan, No. 162, pp. 14–15 (♂, ♀; Honduras, Guatemala=*scalaratus* Bell.). Not *C. lateralis* Wied., 1828.

A series of 12 females from near Almirante, Bocas del Toro Province, Panama, March 12, 1943, Marucci and Wood colls., a further series taken towards the end of August, 1944, by myself at the same locality, and a single female from Robalo on the shores of Chiriqui lagoon, Bocas del Toro Province, January 21, 1946, P. Galindo coll. Hitherto known from Mexico to Costa Rica, the present material extends the range of the species considerably.

Chrysops auroguttata Kröber

Two females from Coclé del Norte, Colon Prov., September 29, 1942; 9 from Robalo, Bocas Prov., January 21, 1946; 2 from Almirante, Bocas del Toro Prov., August 21, 1944, and 3 from Utria and Valle, Choco, Colombia, August 27 and September 1, 1942, Boshell coll.

Bequaert (Psyche, 51, p. 13, 1944) has recently revised the distinctions between *auroguttata* and *pallidefemorata* Kröber, and concludes that the two forms treated by Kröber as varieties of one species, are really distinct species. One of the specimens from each of the two Panama localities listed here approaches *pallidefemorata* in showing a marked encroachment of hyaline into the marginal cell at the apex of the cross-band, and in having the hyaline area in the fifth posterior cell extensive, reaching quite to the discal cell. All have a marked hyaline spot at the base of the first submarginal cell. The three Colombian specimens are darker, the wing markings more typical of *auroguttata*, but the hyaline spot at base of first submarginal cell is almost obsolete.

In 1942 (Proc. Ent. Soc. Washington, 44, 1, pp. 3–4) I concluded, on the basis of very limited material and largely on wing markings, that Panama material came closest to *pallidefemorata*, in this agreeing with Pechuman (1937, Rev. Ent., 7, p. 136). However, the proportions of the frons, and especially the rather long basal antennal segments agree better with both Krober's and Bequaert's definitions of *auroguttata*. I listed the specimens under *incisa* Macq., but Dr. Bequaert believes that species to be unrecognizable from the description.

Chrysops soror Kröber

One female, Jaqué, Darien Prov., February 9, 1943, Marucci and Wood colls.

Chrysops mexicana Kröber

Two females, Almirante, Bocas del Toro Prov., March 12, 1943, 1 female, Robalo, Bocas Prov., January 21, 1946, P. Galindo coll., and 2 females Pito, Intendencia de San Blas, June 20, 1943, Marucci and Wood colls. Those from Almirante agree with my fig. 6 (Fairchild,

1942, Proc. Ent. Soc. Washington, 44, 1, pp. 1–8), those from Pito with fig. 7. Extensive material may show two distinct species, but which, if either, is Kröber's species is uncertain.

Scione maculipennis Schiner

One female, El Volcan, Chiriqui Prov., July 4, 1943, T. Aitken coll. This specimen agrees with others previously reported from the same area (Fairchild, 1942). Two females from Jaqué, Darien Prov., February 9, 1943, Marucci and Wood colls., are unusual in that the locality is at sea level. The specimens are quite different in appearance from those from Chiriqui, being paler, more obscurely marked, and with the wing markings very faint. The frons is like my fig. 6 and the palpi as in fig. 6 b.

Dichelacera analis Hine and **Dichelacera marginata** Macquart

Two females of the former and one of the latter, Robalo Bocas del Toro Prov., January 21, 1946, P. Galindo coll. Both these species are on the wing only until November or early December on the Pacific side of the isthmus, but the lack of a well marked dry season on the Caribbean side evidently results in a much longer flight season.

Dichelacera (Psalidia) fulminea (Hine)

One male and 6 females from near Almirante, Bocas del Toro Prov., Panama, March 12, 1943, Marucci and Wood, and August 18, 1944, Fairchild. The male is quite similar to the female, but paler, and the dark markings of the wing are considerably reduced. The first posterior cell is open, though narrowly so, while the antennae are more slender and with a shorter tooth than in the female. A female from France Field, C. Z., September 30, 1943, Keenan coll., and another from Muzo, Dept. of Boyacá, Colombia, June 14, 1941, Gast Galvis coll., both show the first posterior cell open, quite widely so in the Panama specimen. This constitutes an exception to the statement (Fairchild, 1940, Ann. Ent. Soc. Amer., 33, p. 692) that this species always has the cell closed, and is a further confirmation of the worthlessness of this character for even specific definition.

Dichelacera (Catachlorops) transposita (Walker)

Three additional females (Pito, Int. de San Blas, June 20, 1943, Marucci and Wood colls.) of this interesting species enable certain corrections to be made to my earlier description (Fairchild, 1940). The sides of the mesonotum and apical third of the scutellum are clothed with white hairs, as is the posterior margin of the last visible tergite. The mid-tibiae are hardly white basally, merely somewhat paler than the remainder of the tibia.

Dicladocera badia Kröber

Nine females from Robalo, Bocas del Toro Prov., January 21, 1946, P. Galindo coll. This species has previously been taken only at Bocas del Toro and Porto Bello, and at El Valle, in Coclé Province. Dr.

Galindo, the collector, said he was informed it had been very abundant a few weeks previously, attacking both man and horses.

Cryptotylus luteoflavus (Bellardi)

Male.—Eyes bare, holoptic, not enlarged. The large facets are but very slightly enlarged, so that a superficial examination would suggest that all facets are of one size. The line of demarkation between large and small facets is imperceptible, and the area occupied by the large facets seems not to exceed about one-third of the total eye area. Vertexal tubercle well developed. Frontal triangle yellow pollinose. Antennae more slender than in female, the dorsal angle slightly more acute. Palpi erect, rather small and slender. Proboscis long and slender, the labelli partially sclerotized. Color almost wholly dull yellow, considerably paler than the female.

Neallotype male, Almirante, Bocas del Toro Province, March 12, 1943, Marucci and Wood colls.

The lack of enlarged eye facets and reduced antennal tooth place this species somewhat apart from its congeners, but the color, general facies, and vertexal tubercle indicates that it is closer to *Cryptotylus* than to *Chlorotabanus*. It is perhaps the least specialized member of the group, approaching in some aspects certain species of *Stenotabanus*.

Diachlorus curvipes Fab.

Male.—Eyes greatly enlarged, causing the head to be markedly wider than the thorax, holoptic, the large facets many times larger than the small, sharply demarcated from them, and occupying over two-thirds of the total eye area. The area of large facets is pale tan, with, in the lower third, a thick, dark, inverted U-shaped mark. Vertexal tubercle present, though small. Frontal triangle golden yellow pollinose. Palpi as large as in the female but more slender, yellow. Coloration much as in the female, though paler throughout. Mesonotal dark markings reduced, the median yellow stripe somewhat broader than in female. Abdomen wholly yellow and apparently wholly yellow haired.

Neoallotype male, Almirante, Bocas del Toro, Panama, March 12, 1943, Marucci and Wood colls.

This appears to be the second species of *Diachlorus* of which the male has been described, Lutz (1913) having figured the male head of *D. conspicuus*, a closely related species. Two females of *curvipes* from the same locality were taken by myself August 18, 1944. These records extend the known range of the species nearly to the Costa Rican border.

Diachlorous jobbinsi Fairchild

Five females from near Almirante, Bocas del Toro Prov., Panama, taken in March and August, extend the range of the species considerably and enable a few additions to the description to be made. The eye pattern in fresh material differs slightly but consistently from the pattern in *curvipes*, the green markings being more slender throughout. Due to an oversight, no figure of this species accompanied the original description (Fairchild, 1942, Ann. Ent. Soc. Amer., 35, p. 296), so for the sake of completeness the species is here figured.

Stenotabanus (Stenotabanus) lerida Fairchild

Three females from El Volcan, Chiriqui Prov., March 6, 1943, T. Aitken coll. This is apparently one of the commonest Tabanids in the Volcan area.

Stenotabanus (Stenotabanus) maruccii, sp. nov.

Female.—Length 10 mm., of wing 10 mm. Eyes bare, in life green with a single broad median purple stripe. Frons parallel sided, about 4 times as high as wide, yellowish grey pollinose Frontal callus black, nearly as wide as frons basally, tapering to a point at about the middle of the frons. Vertexal tubercle prominent, pollinose, and with well-marked vestiges of ocelli. Subcallus, face and cheeks yellowish brown pollinose, the latter with scattered dark erect hairs. Antennae reddish, the first two segments not inflated and with black hairs. Third segment with the dorsal angle acute and bearing a tuft of black hairs. Annulate portion black, hardly half the length of the basal portion. Palpi brownish, moderately slender, blunt-tipped, black haired. Proboscis about two-thirds head height, blackish, the labelli large and membranous. Beard sparse, greyish.

Mesonotum blackish, with a pair of narrow submedian yellowish stripes reaching the scutellum. Lateral margins yellowish and brassy haired. Scutellum blackish, with sparse brassy hairs. Pleura yellowish grey, a dark stripe passing forward from the wing bases. Legs wholly black and black haired. Wings with subepaulet bearing macrotrichia, but less dense than on the costa. Costa, subcosta, and first vein above with macrotrichia. Wings hyaline, the fore border yellowish smoky, and a light though distinct cloud on the fork of the third vein. All cells but the anal open; no appendix on upper branch of third vein. Abdomen mainly black, black haired. First segment wholly and succeeding segments on posterior margins pearly grey pollinose, changing to brilliant pale blue with light of proper incidence. Second, third, fourth and last tergites with small median tufts of pale hairs. Sides of all tergites with sparse pale hairs. Venter black, wholly pearly pollinose, sparsely pale haired on first and second sternites, the rest black haired.

Holotype female, Pito, Int. de San Blas, Panama, June 20, 1943, Marucci and Wood colls. To be deposited in the Museum of Comparative Zoology, Cambridge, Mass.

This little species is structurally closest to the group of *St. lerida* Fchld., though in coloration and general appearance it approaches *tantulus* Hine and *constabulorum* Fchld.

Stenotabanus (Stenotabanus) plenus Hine

One female, Pinogana, Darien Prov., R. P., February 20, 1943, Marucci and Wood colls. The specimen is unfortunately headless, but the species is so characteristic that there is little doubt as to the identification.

Stenotabanus (Stenotabanus) xenium sp. nov.

Female.—Length 14 mm., of wing 11 mm. Frons about 6 times as high as wide, narrowest below, orange brown pollinose. Basal callus

chestnut brown, narrower than frons, club-shaped, extended as a raised ridge more than half the distance to the vertex. Vertexal tubercle present, small, pollinose, but with vestiges of 3 ocelli. Eyes bare, uniformly dark blackish green in life. Antennae orange, only the terminal annulus black. Palpi orange, mostly black haired. Proboscis shorter than head-height, the labelli large and fleshy. Subcallus orange pollinose, without hairs, genae and fronto-clypeus paler with scattered pale hairs.

Mesonotum greyish brown, unstriped. Pleura and sternum pale yellowish. Legs orange brown, black haired, the fore tarsi somewhat flattened. Wings with subepaulet thin and scale-like, pointed, and with about 12 black macrotrichia. Costa, subcosta, first and fifth veins with macrotrichia above. Fork of third vein with a moderate appendage. Whole wing dilute brownish, darker along the costal border. Abdomen bright orange brown, darker apically. Hind margins of tergites with orange hairs, which form complete transverse bands, widest in the middle and at the sides, on segments 2 to 4; segments 1 and 5 to 6 have only mid-dorsal and lateral patches. Rest of abdomen black haired above, orange haired below.

Holotype female and 2 female *paratypes* collected at light, Canal Zone Police Substation, Rio Pequeni, head of Madden Lake, Panama Canal Zone, June 23, 1944. One female *paratype*, San José, Villavicencio, Intendencia de Meta, Colombia, August 1, 1939, M. Bates coll. The specimen from Colombia is a little lighter in color and with slightly broader third antennal segment. *Holotype* and 1 *paratype* to be deposited in the Museum of Comparative Zoology, Cambridge, Mass.

This little species is close to *St. pequeniensis* Fchld., also from the Rio Pequeni, but differs slightly in the shape of frons and antennae, in having prominent bands of orange hairs on the abdomen, in the less prominently marked wings, and in larger size.

Stenotabanus (Aegialomyia) paitillensis Fairchild

Two females taken attempting to bite in a patch of thorny scrub on the tide flats near the salt pans at Aguadulce, Panama, March 4, 1944. These are the only specimens that have been taken since the type was collected.

Tabanus praepilatus Fairchild

Five females in poor condition taken in a mosquito stable trap at Old Panama, August 17, 1943, and two others from Juan Diaz, May 10, 1943, collected by Sr. Beleño.

Tabanus punctipleura Hine

1920, Ohio Journ. Sci., 20, No. 8, pp. 314–315 (♀, San Carlos and Carillo, Costa Rica). Kröber, 1930, Zool. Anz., 86, 9–10, pp. 261–262; 1934, Rev. Ent., 4, 3, p. 296.

Tabanus (*Lophotabanus*) *defilippi* Kröber, 1929, Zool. Anz., 83, 1–4, pp. 126–127, fig. 8 (nec *de-filippii* Bell., 1859).

A single female from near Almirante, Panama, August 18, 1944. Kröber's (1929) description states that the frons is six times as high as wide, but his figure shows it but four times as high as wide. The

length of, and angle at which, the antennal tooth arises is also greater in his figure than in my specimen. The accompanying figure will serve for comparison.

Structurally this species is close to *T. importunus* and *T. ferrifer*, but the dark color and prominent prescutellar spot give it a strong superficial resemblance to *T. (Bellardia) de-filippii*. These two species form in many ways connecting links between the two groups.

Tabanus praeteritus sp. nov.

Female.—Length 12–13 mm., of wing 11–12 mm. Eyes bare, in life dull green, unbanded. Frons about 4½ times as high as basal width, slightly narrowed below, yellowish grey pollinose. Frontal callus yellowish brown, narrower than frons, higher than wide and prolonged in a short line above. Vertexal tubercle wholly absent. Subcallus, frontoclypeus and genae yellowish grey pollinose, with a fairly dense grey beard. Antennae orange yellow, the first segment somewhat inflated, the third with a fairly well-marked dorsal angle and the darker annulate portion somewhat shorter than the basal portion. Palpi pale yellowish, black haired, inflated basally but with a rather slender apex. Proboscis short, less than head height, the labelli membranous and over two-thirds length of proboscis.

Mesonotum dark grey, unstriped, with mixed dark and brassy hairs. Pleura and sternum steel grey, sparsely pale haired. Scutellum concolorous with mesonotum. Legs orange brown, the fore femora, apical halves of fore tibiae and bases of mid- and hind femora darker. Wings with subepaulet, costa, subcosta and first vein setose. All cells but anal open, no appendix on branch of third vein. Wings entirely hyaline except for the yellowish stigma and faintly tinged costal cell. Abdomen mainly dull yellowish brown with, on the first two tergites, a narrow and not well defined inverted black triangle. The fourth and succeeding segments are darker in the middle, though there is no well defined stripe. The abdomen is mainly densely black haired, but with oval patches of yellow hairs dorsolaterally on the second to fifth tergites. On one specimen there is a very faint indication of a middorsal pale line. Sternites pale yellowish, wholly pale haired.

Male.—Eyes bare, holoptic, the facets hardly differentiated, those on the disk being very slightly larger than those on the margins. Vertexal tubercle present, small, densely haired. Coloration as in the female,

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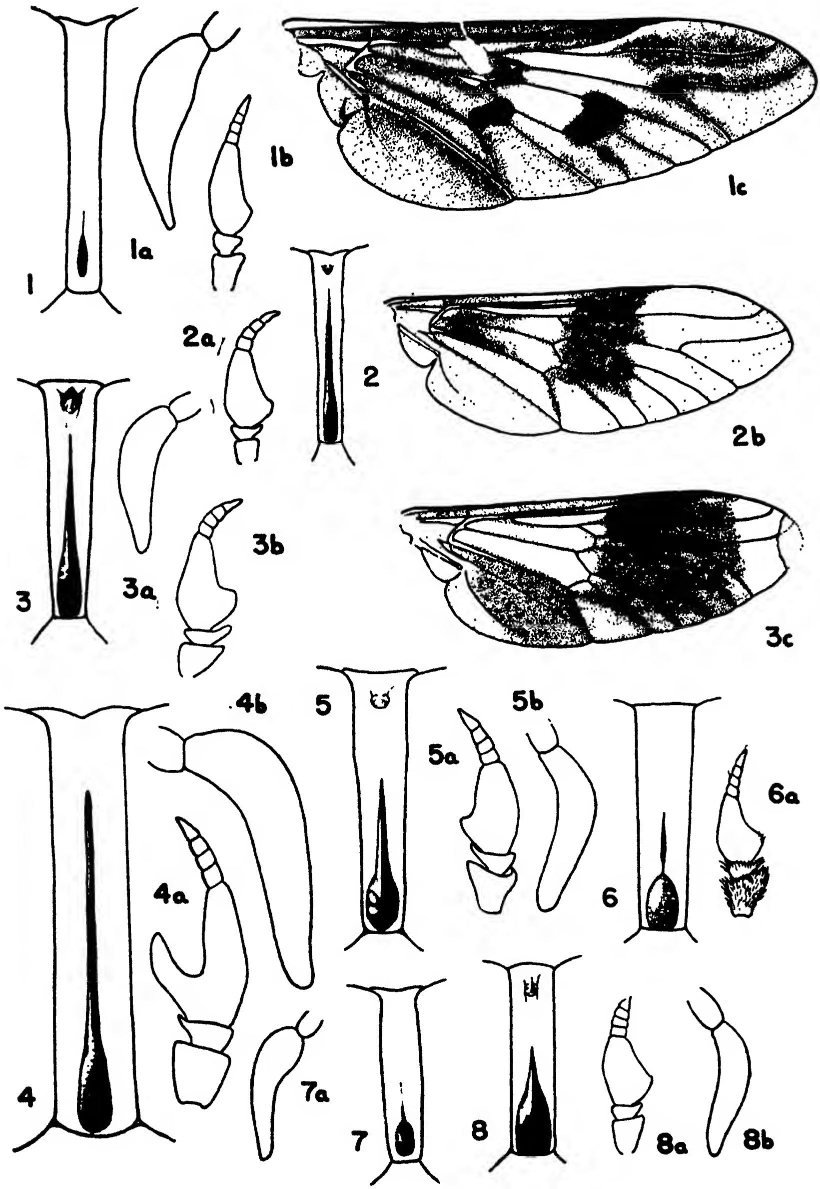
EXPLANATION OF PLATE I

All figures are of the frons, antenna and/or palpus of female specimens, and are all to the same scale as that used in my previous papers on Panama Tabanidae. The figures of wings are drawn from specimens mounted in balsam, and are to a somewhat smaller scale than the other figures.

FIGS. 1, 1a, 1b, 1c, *Tabanus xenorhynchus* sp. now. Holotype (head structures) and Paratype (wing). FIGS. 2, 2a, 2b, *Tabanus (Philipotabanus) keenani* sp. nov. Holotype. FIGS. 3, 3a, 3b, 3c, *Tabanus (Philipotabanus) inauratus* sp. nov. Holotype. FIGS. 4, 4a, 4b, *Tabanus punctipleura* Hine. FIGS. 5, 5a, 5b, *Stenotabanus (Stenotabanus) xenium* sp. nov. Holotype. FIGS. 6, 6a, *Tabanus praeteritus* sp. nov. Holotype. FIGS. 7, 7a, *Diachlorus jobbinsi* Fairch. FIGS. 8, 8a, 8b, *Stenotabanus (Stenotabanus) maruccii* sp. nov. Holotype.


1
1a
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5b
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6a
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7a
8
8a
8b

but a little lighter in tone. One specimen has a clearly indicated middorsal line, the other not. In the first of these specimens, the upper branch of the third vein, r_4, and veins m_2 and m_3 are incomplete in both wings.

Holotype female, Chepo, Panama Province, Republic of Panama, January 19, 1930, L. H. Dunn coll. *Allotype* male, Ancon, Canal Zone, A. H. Jennings coll. *Paratypes*, 2 females with some data as holotype, 1 female, Porto Bello, Panama, March 2, 1911, A. Busck coll., 1 female, El Real, Darien Prov., Panama, February 7, 1940, D. M. Jobbins coll., 1 female Christobal, Canal Zone, November 2, 1939, Holder coll., 1 male, Ft. Randolph, Canal Zone, January 23, 1929, C. H. Curran coll.

Holotype and 1 female *paratype* to be deposited in the M. C. Z., *Allotype* and 1 female *paratype* in the U. S. National Museum, the male paratype in the American Museum of Natural History, and remaining paratypes in author's collection.

This little species has remained unnamed in my collection for a number of years. I had thought for a time it might be *T. sallei* Bell., and there is little in the description to disagree, but it has so few outstanding characteristics and belongs to a group of very similar appearing species which are only to be distinguished by small structural characters, that I feel obliged to describe it. Its relationships seem to be with the *nigrovittatus* group, its nearest allies in Panama being *T. rixator* Fairch. and *T. nereus* Fairch.

Tabanus xenorhynchus sp. nov.

Female.—Length 16–17 mm., of wing, 15–16 mm. Eyes bare, probably uniformly dark blackish green in life. Frons about 8 times as high as basal width, slightly narrowed below the middle, light grey pollinose. Basal callus weakly developed, brown or blackish, about one-third width of frons and about 3 to 4 times as high as wide, slightly prolonged above. Vertex with a small discolored spot, but without a distinct tubercle. Antennae dark brown to blackish, the basal portion of third segment slender, somewhat less than twice the length of the annulate portion and with a moderate dorsal angle near the base. Palpi blackish or dark brown, black haired, the terminal segment basally inflated, with slender acute apex and longer than antennae. Proboscis long, about equalling head height, the labelli about half its length, wholly membranous. Subcallus, fronto-clypeus and genae brownish grey pollinose, beard brownish, sparse.

Mesonotum chocolate brown, with a pair of dorsolateral white lines reaching the scutellum. Sides of mesonotum and posterior border of scutellum with long and dense silvery white hairs. Pleura and sternum blackish, wholly black haired. Legs wholly black and black haired. Wings with subepaulet, costa, subcosta, first and fifth veins with macrotrichia above. All cells but anal open, no appendix at fork of third vein. Stigma pale yellowish. Apical and anal areas of wing and first basal cell lightly infuscated, and all cross-veins with large dark clouds.

Abdomen dark brown, black haired, but with the following patches of silvery white hairs. Small middorsal triangles on the first, second and fifth tergites, and a large patch on the fourth tergite. Lateral tufts on

the first, second and third tergites, smallest on the first. Sternum dark and dark haired.

Male.—Eyes bare, the area of large facets about one-half area of the small facets, the areas fairly well demarcated. Vertexal tubercle present. Antennae much more slender than in female. Mesonotum without white stripes or lateral white hairs, only the scutellum being white margined. Abdomen with small tufts of white hairs on second, fifth and sixth tergites, a large white haired patch on fourth tergite. No lateral white patches. Wings and other characters as in the female.

Holotype, female, Escobal, Colon Province, Panama, March 11, 1945, C. M. Keenan coll. *Allotype* male, Barro Colorado Island, C. Z., March 17, 1936, W. J. Gertsch coll. One female *paratype,* Cayuga, Guatemala, Schaus and Barnes coll., 1 female *paratype,* Punta Ricles, Golfito, Costa Rica, May 14, 1943, T. Aitken coll. *Holotype* to be deposited in M. C. Z., *allotype* in American Museum of Natural History, 1 paratype in U. S. National Museum, 1 paratype in author's coll.

This species does not seem very obviously related to other middle-American forms known to me, so I have refrained from trying to place it subgenerically. The disproportionately long proboscis is noteworthy.

Tabanus (Philipotabanus) inauratus sp. nov.

Female.—Length 13 mm., of wing, 11 mm. Frons about 7 times as high as basal width, slightly narrowed below, pale grey pollinose. Callus black, club-shaped, about half width of frons basally and extending as a raised ridge nearly to vertex. Vertexal tubercle prominent, with vestiges of 3 ocelli, and placed upon a triangular black denuded area. Subcallus dark grey pollinose. Face and cheeks dark grey pollinose, both with fairly numerous erect grey hairs. Eyes apparently unbanded, greenish black. Antennae black, black haired. First segment somewhat swollen, second with a long dorsal spine, third with the basal part longer than wide, longer than the annulate part and with a prominent though blunt dorsal angle. Palpi blackish, black haired, rather slender. Proboscis black, short, the large membranous labelli accounting for three-fourths of its length.

Mesonotum black, black haired on the disk, but with a patch of rich golden hairs on each side at the transverse suture, and with the whole posterior border of the mesonotum and whole scutellum densely clothed with rich golden hairs. Pleura and sternum black, grey pollinose, mostly black haired, except for tufts of white hairs beneath and above wing bases. Legs black, black haired, except a tuft of long white hairs on bases of fore coxae. Wings with subepaulet, costa, subcosta and first vein all with dense macrotrichia. Venation normal, no appendix on fork of third vein. Wing largely black, apex hyaline, basal cells yellowish hyaline, costal cell brown, anal area somewhat dilute blackish. Abdomen above mostly black and black haired, but sides of first and second tergites and a broad middorsal patch on fourth tergite silvery white haired. Venter wholly black.

Holotype female, Almirante, Bocas del Toro Prov., Panama, March 12, 1943, Marucci and Wood colls. One female paratype, Ft. Sherman Reservation, C. Z., March, 1945, Keenan coll. To be deposited in the Museum of Comparative Zoology, Cambridge, Mass.

This very striking species is an interesting and handsome addition to the Panama fauna. It seems most closely related to *T.* (*Ph.*) *fascipennis* Macq., from which it differs in the golden haired scutellum, broader frons, stouter palpi, and almost wholly clear basal cells of the wing.

Tabanus (Philipotabanus) magnificus Kröber

Three females, Almirante, Bocas del Toro Prov., March 12, 1943, 1 female, Chiriqui Point, Bocas del Toro Prov., April 1, 1943, and 1 female, Pito, Intendencia de San Blas, June 20, 1943, all Marucci and Wood colls.

Tabanus (Philipotabanus) keenani sp. nov.

Female.—Length, 11 mm., of wing, 11 mm. Frons narrow, a little over 7 times as high as basal width, narrower below, dark yellowish grey pollinose. Basal callus black, club-shaped, about half as wide as frons and extended upwards as a narrow raised line two-thirds of the distance to the vertex. Vertexal tubercle not prominent, represented by a small bare spot. Antennae yellowish orange throughout, the upper angle on the third segment poorly developed. Palpi slender, dark brown, black haired. Subcallus, fronto-clypeus and genae dull yellowish grey pollinose. Beard sparse, of mixed grey and black hairs and confined to the lower parts of the genae. Eyes bare, unicolorous, probably dark bronzy or greenish in life.

Mesonotum and scutellum light chocolate brown, the former sparsely black haired, the latter with pale hairs. Pleura dark grey with sparse dark hairs. Legs wholly black and black haired. Wings with sub-epaulet setose and no appendix on fork of third vein. Wing markings reduced to a discal patch below the stigma and including the whole discal cell and extreme bases of all posterior cells. The proximal halves of the basal cells and most of the costal cell are also brown. Abdomen black and black haired, the posterior margins of all tergites and most of the first tergites bluish white pruinose. Beneath, the pruinosity is more extensive.

Holotype female, near Piña, Colon Province, Panama, October 14, 1943, C. M. Keenan coll. To be deposited in the Museum of Comparative Zoology, Cambridge, Mass.

This species appears to connect in some ways the species, such as *medius* Kröb., having hyaline fenestrae about the cross-veins, with those in which the dark pattern is solid, like *fascipennis* Macq. The lack of fenestrae will separate it from any of the former group, while the greatly reduced pattern will distinguish it from *fascipennis* and its allies. Named in honor of the collector, Mr. C. M. Keenan, Assistant Sanitary Inspector for the Panama Canal Department.

Tabanus (Bellardia) albocirculus Hine[2]

Six females, Almirante, Bocas del Toro Prov., March 12, 1943, Marucci and Wood colls., August 18, 1944, Fairchild coll., and Robalo,

[2]Dr. Bequaert informs me that *Lophotabanus* Szilady is the correct name for this group, *Bellardia* Rondani 1863 being presumably preoccupied by *Bellardia* Rob.-Desv. 1863, in the Tachinidae.

January 21, 1946, P. Galindo coll. These are the darkest specimens seen from Panama, being nearly coal black in ground color, with heavily fumose wings. They are also much larger than specimens from the Pacific coast.

Tabanus (Hybomitra) quadripunctatus Fab.

A single female approaching the variety *amabilis* Walk. from Almirante, Bocas del Toro, March 12, 1943, Marucci and Wood colls.

Tabanus (Neotabanus) unistriatus Hine

Two females from near Almirante, Panama, August 21, 1944. This locality is on the Caribbean coast whereas the only previous known records in Panama were from the Pacific coast in Chiriqui Province.

Tabanus (Neotabanus) vittiger var. **guatemalanus** Hine

A single female from Mt. Hope, C. Z., June 28, 1944, Keenan coll., invalidates the statement (Fairchild, 1942, p. 181) that this form is confined to the Pacific coast of Panama, as Mt. Hope is on the Atlantic side.

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THE GENUS URANOTAENIA LYNCH ARRIBALZAGA IN PUERTO RICO

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The discovery of *Uranotaenia cooki* Root in Puerto Rico has made it desirable to restudy all stages of the three local species of *Uranotaenia*.

Uranotaenia Lynch Arribalzaga (1891) is such a well-defined genus that a number of authorities such as Dyar (2) and Neveu-Lemaire (8) have felt justified in making it the type genus of a distinct tribe Uranotaeniini in the subfamily Culicinae.

The adults are easily recognized by their small size, and the bluish-white scales on the thorax, abdomen, or basal portion of the wing. More fundamental characters visible with suitable magnification are the very fine microtrichiae in the wing membrane, the second marginal cell less than half as long as its petiole, the short anal vein which ends before the level of fork of Vein 5 (Cu), and the short palpi in both sexes. The female *Uranotaenia* have only one sclerotized spermotheca, in this respect resembling *Anopheles* and differing from most of the culicine genera.

The following key will serve to separate the adults of the three Puerto Rican species, the first two of which occur in southeastern United States:

KEY TO ADULT PUERTO RICAN URANOTAENIA

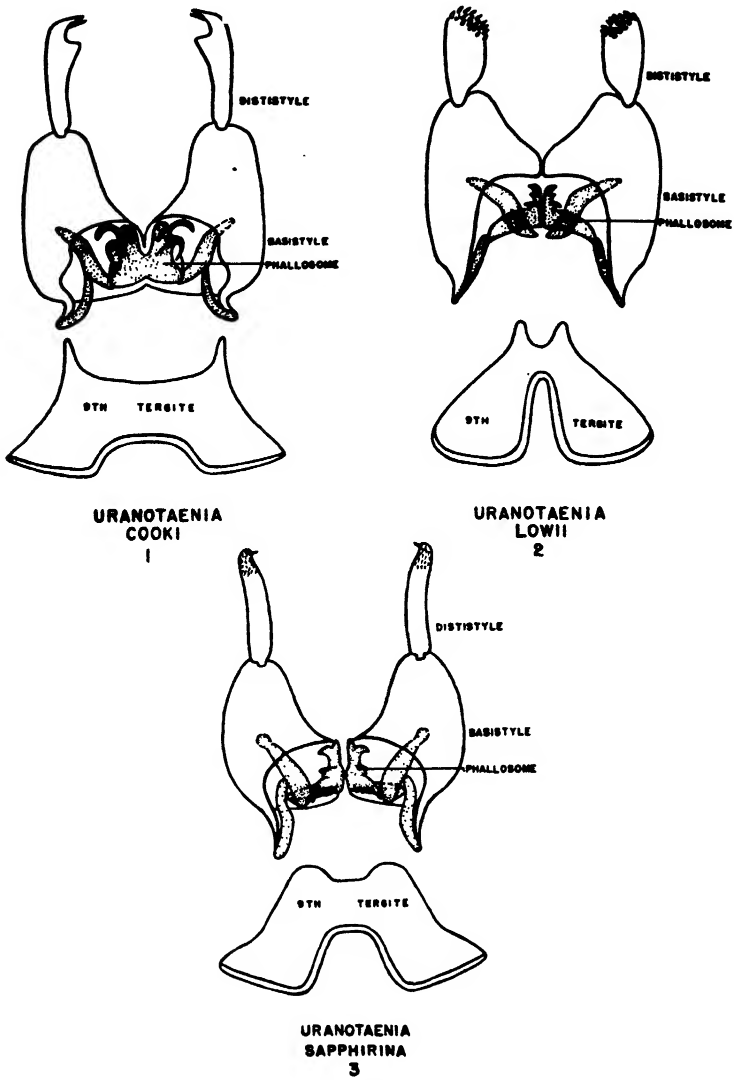
1. Hind tarsus with last two segments entirely white; tip of hind femur and hind tibia without or with small white spots; small species averaging 1.5 mm. long .... **lowii**
   Hind tarsus entirely black, tip of hind femur and hind tibia with conspicuous white spot; larger species averaging about 2 to 3 mm. long 2
2. Mesonotum with narrow, median, longitudinal stripe of bluish scales; abdomen without white spots laterally; fore tarsus of male normal, **sapphirina**
   Mesonotum without median, longitudinal stripe of bluish white scales; abdomen with conspicuous white or bluish-white spots laterally; first segment of fore tarsus in male shorter than second segment .... **cooki**

The male terminalia of the three Puerto Rican species of *Uranotaenia* are likewise very distinct. The important diagnostic characters are found in the shape of the dististyle (clasper), in the structure of the phallosome, and in the shape of the ninth tergites. A key based on characters of male terminalia is given below:

A KEY TO THE MALE TERMINALIA OF PUERTO RICAN URANOTAENIA

1. Dististyle (clasper) about as long as broad at apex, with 15 to 25 strong spines distally (fig. 2) .... **lowii**
   Dististyle (clasper) nearly twice as long as broad with one terminal spine 2
2. Dististyle (clasper) but slight expanded in middle; phallosome plates with three short teeth; ninth tergite with short, rounded shoulders and narrow interlobar space (fig. 3) .... **sapphirina**
   Dististyle (clasper) strongly expanded slightly beyond middle; phallosome plates with three long, curved, finger-like lobes; ninth tergite with longer, pointed lobes and broad interlobar space (fig. 1) .... **cooki**

The larvae of *Uranotaenia* are often mistaken in the field for those of *Anopheles* because of the nearly horizontal angle at which they hang from the surface of the water. In the Nearctic and Neotropical regions



FIGS. 1 to 3. Male terminalia of the three Puerto Rican species of *Uranotaenia*.

all the species of *Uranotaenia* (except *U. anhydor* and *U. syntheta*) may be distinguished from all other Culicinae by their elongate, pear-shaped head with four, stout spines dorsally (the upper and lower head hairs

of American authors and the inner and mid frontal hairs, Nos. 5 and 6 some Old World authors).

The larvae in this genus are remarkably similar and great care must be taken in making specific determinations of this stage. Dyar (2) had noted the importance of the number of teeth on the sclerotic plates on abdominal segment VIII, while King, Bradley, and McNeel (6) have shown the value of upper lateral hair on abdominal segments I and II. More recently Pryor and Chamberlain (10) have shown that the length and number of branches in the No. 3 hair of the anterior, submedian, prothoracic group are important taxonomically, while Dodge (1) has found good diagnostic characters in the branching of prothoracic hair No. 13. The number of branches of the postclypeal hair (No. 4) also seems to have specific value. The characters given in the following key apply only to fourth stage larvae. Fourth stage larvae have the anal segment completely encircled by a sclerotized plate, whereas this plate never completely surrounds the segment in younger larvae.

KEY TO FOURTH STAGE LARVAE OF PUERTO RICAN URANOTAENIA

1. Upper lateral hair of abdominal segments I and II triple; postclypeal hairs single or double; branches of No. 3 hair of anterior, submedian, prothoracic group about half as long as Nos. 1 and 2 hairs; hair 13 of prothorax multiple (fig. 6) . . . . **sapphirina**
   Upper lateral hair of abdominal segments I and II double (lower lateral hair single in all species) postclypeal hairs triple or multiple; branches of No. 3 hair of anterior submedian prothoracic group almost as long as Nos. 1 and 2 hairs; hair 13 of prothorax single 2
2. Comb scales on posterior edge of sclerotic plate usually 10 or more in number: head of live larvae usually golden brownish (fig. 4) . . . . **cooki**
   Comb scales on posterior edge of sclerotic plate usually less than 10 in number, often 8; head of live larvae blackish (fig. 5) . . . . **lowii**

The pupae of *Uranotaenia* differ from most other culicine pupae in having the part of the paddle inside of the mid-rib conspicuously wider than that outside. The shape of the respiratory trumpet is characteristic for each species. In addition the number of fine branches in abdominal hairs VIB and VIIB is of some use.

KEY TO PUPAE OF PUERTO RICAN URANOTAENIA

1. Respiratory trumpet short, about 3 to 5 times as long as diameter of middle portion of trumpet (fig. 7) . . . . **lowii**
   Respiratory trumpet longer, 6 to 10 times as long as diameter of middle portion of trumpet 2
2. Respiratory trumpet with a broad, V-shaped truncation; hair VIB and VIIB with two strong branches and several finer ones (fig. 8) . . . . **sapphirina**
   Respiratory trumpet with shorter truncation, and a very sudden, sharp V-shaped notch in the middle of truncation; hairs VIB and VIIB with several strong branches (fig. 9) . . . . **cooki**

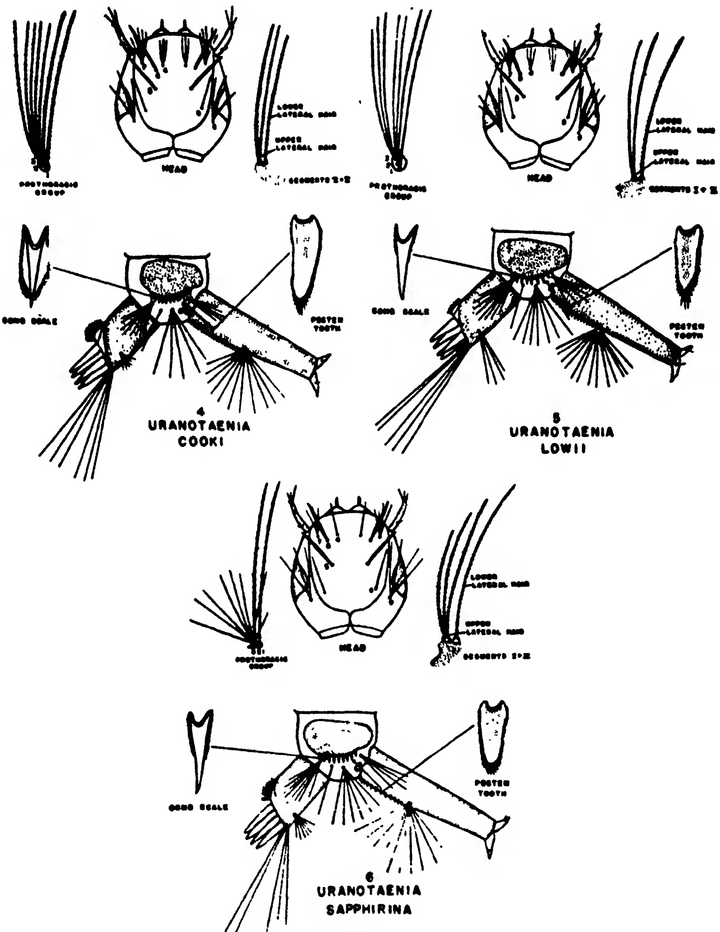
Uranotaenia cooki Root

Uranotaenia cooki Root, 1937, Journ. Par. 23: 98.
Uranotaenia cooki Pritchard and Pratt, 1944, Pub. Health Rpts., 59: 233.
Uranotaenia cooki Weathersbee, 1944, P. R. Journ. P. H. Trop. Med., 19: 643.

Recognition characters: Adult.—A small, delicate mosquito with bluish scales on thorax, wings, and base of abdominal segments laterally. It resembles *sapphirina* in size and dark hind tarsus, but has no

median line of bluish scales on the bronzy brown mesonotum. It is similar to *lowii* in having patches of silvery-blue scales laterally on the abdomen. The male is very distinct from either species in having the first segment of fore tarsus conspicuously shorter than the second.

Male terminalia: (fig. 1) Dististyle about twice as long as basal width, with a conspicuous swelling before tip, one apical spine on clasper;



FIGS. 4 to 6. Larval structures of the three Puerto Rican species of *Uranotaenia*.

phallosome plates with 3 long, curved, finger-like lobes. Ninth tergite with long, pointed lobes and broad interlobar space.

Larva: (fig. 4) Head elongate-elliptical, pear-shaped, light yellowish or golden-brown; preclypeal hairs (No. 1) short, stout, peg-like; postclypeal hairs (No. 4) 3-branched; upper and lower head hairs (Nos. 5 and 6) single, stout, very slightly spicular under high magnification;

anteantennal hairs (No. 7) 5- or 6-branched; sutural hair (No. 8) single; trans-sutural hair (No. 9) 4- to 6-branched; antenna short, sparsely spicular, with a single hair at basal third. Anterior, submedian, prothoracic group with hairs all originating from a single sclerotic plate, the No. 3 hairs usually 6- to 9-branched, the branches nearly as long as No. 1 or No. 2 hairs. Hair 13 of prothorax single. Upper, lateral hair on abdominal segments I and II double, occasionally triple, lower lateral hair single. Long lateral hairs on abdominal segments III to VII multiple. Sclerotized lateral plate on eighth segment with a row of 10 to 14 teeth on its posterior margin, each tooth triangular, membrane with fringe on lateral sides more conspicuous than in *lowii* or *sapphirina*. Air tube slightly tapered toward tip, about 5 times as long as basal width; pecten of 18 to 20 teeth not reaching middle of air tube, each pecten tooth long and slender, fringed on both sides with fringe longest at apex; a many-branched siphonal tuft just beyond pecten. Anal segment longer than wide, ringed by a sclerotic plate, with spines posteriorly, saddle tuft of 4 to 6 hairs; ventral brush posteriorly. Anal gills four, not quite as long as anal segment.

Pupa: (fig. 9) Respiratory trumpet longer than in *lowii*, about the same length as in *sapphirina*, but with a broader truncation apically and a sudden, sharp, V-shaped notch in middle of truncation.

Biology: Not much is known about the biology of *Uranotaenia cooki*. Capt. S. S. Cook told the writer that he collected adults under the bank of a rocky stream across from his home in Port-au-Prince, Haiti. Root (11) in his original description, quotes a letter from Capt. S. S. Cook describing the habitat as follows: "Flood waters erode the banks of the stream and leave jutting ledges of rock. In such places there are small pools of quiet water, constantly shaded and without vegetation, except for the rotting leaves. The adults rest on the under surface of the rocks and fly when disturbed, but immediately return to the dark hiding place."

The Haiti type locality is apparently similar to Los Chinos creek in Gurabo, Puerto Rico where the species has been found at an elevation of approximately 500 feet. In Gurabo no larvae were found, but the adults could be found on densely shaded, damp, mossy rocks in association with adults of *Culex* (*Micraedes*) *americanus* N. L. whose larvae breed in water collections in the axils of the leaves of malanga (*Caladium colocasia*).

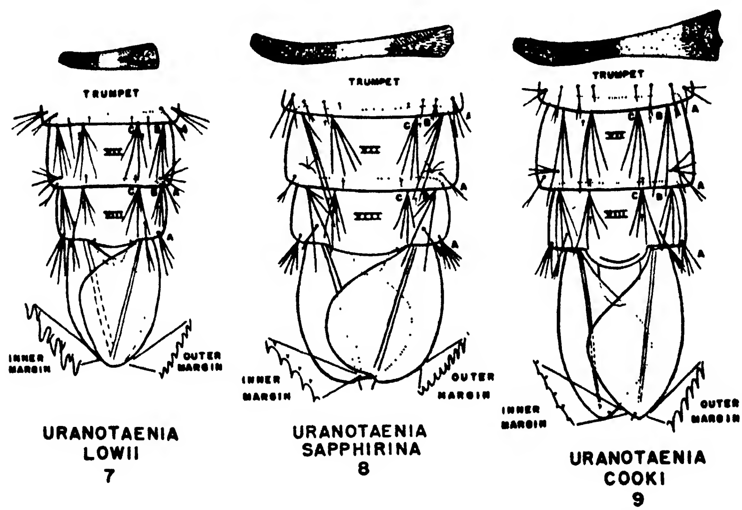
Capt. T. H. G. Aitken and the writer made the first recognized Puerto Rican collections of larvae of *U. cooki*. They were found with the larvae of *U. lowii* and *U. sapphirina* and *Culex opisthopus* Komp about 100 yards from the slaughter house in Barrio Palma, Km. 0.5, Catano, P. R. on Dec. 26, 1942. The water was clean, either in hoof prints or a narrow backwash along the edge of Aguas Claras creek, in most cases well-shaded by the semi-aquatic grass (*Leptochloa virgata*) and a smartweed (*Persicaria acuminata*). This is apparently quite a different habitat than the Haitian type locality of Los Chinos creek in Gurabo, P. R.

More recently *cooki* larvae have been found breeding throughout the year in the Alianza reservoir in Salinas, P. R. This is completely covered with such a dense growth of water hyacinth (*Piaropus crassipes*) that the water is very densely shaded. Associated mosquito larvae in this

reservoir are *Uranotaenia lowii* Theobald, *Uranotaenia sapphirina* (O. S.), *Culex atratus* (Theobald), *Culex chidesteri* Dyar, and *Anopheles vestitipennis* Dyar and Knab.

Although his specimens are not available for checking, it seems probable that *U. cooki* Root is the third species of *Uranotaenia* mentioned by Tulloch (13). A specimen of this species was taken in net collections in a thickly wooded area at Mayaguez, P. R., in May, 1936.

Adults have been collected in a light trap on the Fort Buchanan Reservation on February 9, 1943; at Carolina, P. R., in March and April, 1944; at Camp Tortuguero in March, 1943; and at Humacao throughout the year, Oct., 1944, to Oct., 1945. Capt. T. H. G. Aitken observed mating, end to end facing in opposite directions, in a lantern chimney approximately 5 inches in diameter and 6 inches tall, so *Uranotaenia cooki* is *stenogamous*, i. e., will mate in small containers.



FIGS. 7 to 9. Trumpets and terminal abdominal segments of the pupae of the three Puerto Rican species of *Uranotaenia*.

All the larvae of *cooki* collected in the field have had a characteristic golden-brown head, whereas *sapphirina* usually has a dark brown to blackish head, and *lowii* almost always has a blackish head.

Distribution.—Haiti: Port-au-Prince, type-locality. Puerto Rico: Humacao (R. E. Serfling); Ensenada Honda (A. Weathersbee and G. E. Bohart (14)), Loiza, Carolina, Catano, Gurabo, Vega Baja, Salinas, Ponce, (H. D. Pratt). Virgin Islands: Spring Gut Stream, St. Croix, Dec., 1934, H. A. Beatty (Det. Alan Stone, 1 female and 2 males in U. S. National Museum.)

Uranotaenia lowii Theobald

Uranotaenia lowii Theobald, 1901, Mon. Cul., 2: 339.

Recognition characters: Adults.—A small, delicate mosquito with bluish scales on thorax and wings. Mesonotum bronzy-brown, with a

darker spot on each side near base of wings. Abdomen with patches of bluish of white scales laterally. Wing scales brown, basal part of first and fifth veins with blue scales. Hind tarsus with last two segments white, tip of hind tibia dark.

Male terminalia: (fig. 2) Distisyle very stout, only slightly longer than broad, inner surface of distal half with a patch of 15 to 25 stout spines. Ninth tergite longer antero-posteriorly than in *cooki* or *sapphirina*, with pointed lobes and narrow interlobar space.

Larva: (fig. 5) Head much longer than wide, pear-shaped, blackish. Hairs Nos. 5 and 6 single, stout, minutely serrulate. Postclypeal hairs (No. 4) triple or rarely multiple; No. 3 hair of anterior, submedian prothoracic group with 5 to 7 branches almost as long as Nos. 1 and 2 hairs. Prothoracic hair No. 13 single. Upper lateral abdominal hair on segments I and II double. Lateral comb of eighth segment a row of approximately eight teeth on posterior margin of a chitinized plate. Anal segment ringed by sclerotized plate, posterior margin fringed with a row of fine spines. Air tube slender, straight, about three times as long as basal width; hair tuft multiple, about in middle of tube; pecten reaching to tuft.

Pupa: (fig. 7) Respiratory trumpet short, about three to five times as long as diameter of middle portion of trumpet.

Biology: Uranotaenia lowii is one of the commonest mosquitoes in light trap collections in Puerto Rico, 500 to 1000 specimens of both sexes sometimes being collected in a single, overnight catch. It is found in traps throughout the year most abundantly during the rainy season. Larvae occur in semi-permanent to permanent pools of water with algal mats vegetation, associated with larvae of *Culex*, *Anopheles*, *Corethrella*, and sometimes *Psorophora* or *Aedes*. It has been found at Catano, P. R., in marsh meadow pools about a week to ten days following flooding or heavy rainfall at the time when *Psorophora confinnis* and *Aedes tortilis* larvae had pupated and were emerging and *Culex nigripalpus* and *Anopheles albimanus* were replacing them in the ecological succession of species. Male and female specimens *in copula* end to end facing in opposite directions, have been collected on *Lemna* fronds or floating vegetation on the surface of the breeding places. Larvae occur throughout the year, perhaps in greatest numbers toward the end of the rainy season in November, December and January. The life cycle has not been completely worked out but the length of the larval and pupal stages in the laboratory suggests that a complete generation from egg to egg, requires two to three weeks. The females have not been found sucking human or animal blood in Puerto Rico.

Distribution: Dyar (2) reports the species from the Gulf States, Antilles, Panama, Ecuador, Colombia, Venezuela, Trinidad, the Guianas and Argentina. Caribbean records of interest include the following:

Vieques: Puerto Mosquito at liht gtrap May and June, 1943, (H. D. Pratt). Puerto Rico: Humacao (R. E. Serfling), Ceiba, Naguabo, Loiza, Carolina, San Juna, Rio Piedras, Catano, Guaynabo, Caguas, Gurabo, Vega Baja, Aguadilla, Lake Cartagena, Ponce, Juana Diaz, Salinas (H. D. Pratt), Mayaguez, Guanica, Rincon, Lake Cartagena (G. S. Tulloch (13)). Haiti: Port-au-Prince, Aug. 21, 1924. W. A.

Hoffman (Root (10)). Jamaica: Fort Simonds, Sept. to Dec., 1944. ·G. A. Thompson.

Uranotaenia sapphirina (Osten Sacken)

Aedes sapphirinus Osten Sacken, 1868, Trans. Amer. Ent. Soc., 2: 47.
Uranotaenia socialis Theobald, 1901, Mon. Cul., 2: 340.

Recognition characters: Adult.—A small, delicate mosquito with bluish scales on thorax and wings. Mesonotum bronzy-brown, with a narrow median line of metallic blue scales extending from anterior margin to scutellum, a lateral row of blue scales extending from base of wing to middle of mesonotum. Abdomen without patches of bluish or white scales laterally. Wing scales brown, basal part of first and fifth veins with bluish scales. Hind tarsus entirely black, tip of hind tibia with a large white spot.

Male terminalia: (fig. 3) Diststyle slender, about twice as long as wide, with scattered setae on apical half. Ninth tergite with short, rounded lobes and narrow interlobar space.

Larva: (fig. 6) Head much longer than wide, pear-shaped. Upper and lower head hairs (Nos. 5 and 6) single, stout, minutely serrulate when seen under high magnification. Postclypeal hairs (No. 4) single or double. No. 3 hair of anterior, submedian prothoracic group 7- to 11-branched, less than half as long as No. 1 or No. 2 hairs. Prothoracic hair No. 13 multiple. Upper lateral hair on abdominal segments I and II triple. Lateral comb of eighth segment a row of approximately eight teeth on the posterior margin of a flat, chitinized plate. Anal segment ringed by sclerotized plate, posterior margin fringed with a row of fine spines. Air tube slender, straight, three times as long as wide. Hair tuft multiple, about in middle of tube; pecten reaching to tuft.

Pupa: (fig. 8) Respiratory trumpet six to ten times as long as diameter of middle portion, with a broad, V-shaped, apical truncation. Hairs VI B and VII B with two strong branches and several finer ones.

Biology: Uranotaenia sapphirina occurs over most Puerto Rico throughout the year. It does not appear to be as common as *Uranotaenia lowii* and certainly it is taken less frequently in light trap collections. Male and female specimens have been taken mostly in light traps near the breeding places, suggesting a short flight range, possibly not more than half a mile. Larvae are found in clean, semi-permanent to permanent water containing emergent or floating masses of vegetation, or algal mats. The larvae have been found associated with the other two Puerto Rican *Uranotaenia*, the three Puerto Rican *Anopheles*, and several species of *Culex* larvae. It is most common in the upland and central portions of the Island, or in cool coastal marshlands. Lawlor (7) has written that in South Bethlehem, New York females hibernate over-winter, and Hinman (5) found millions inside Fort Jackson, Louisiana, during December, 1934 and January and February, 1935. He noted that these "females were very easily disturbed, suggestive of false hibertation." By March 27, 1935, no females could be found. In Louisiana larvae have been found in January, and from mid-March to

Sept. 18, suggesting hibernation either as larvae or adult females. In Puerto Rico breeding is continuous throughout the year.

Distribution: Eastern United States from New Hampshire and Minnesota south to Florida and Texas, Honduras, Antilles, and Virgin Islands. The following Caribbean records are of interest:

Virgin Islands: St. Croix (Hayes (4) as ***Uranotaenia socialis***) St. Thomas, Estate Donoe, Jan. 3, 1920, Det. H. G. Dyar. From "Annual Rept. Commissioner of Health St. Thomas and St. John, V. I. Fiscal year 1919–1920" (unpublished). Vieques: Isabel Segunda, Esperanza, Dec., 1942, (H. D. Pratt). Puerto Rico: San Juan, Catano, Vega Baja, Arecibo, Aguadilla, Mayaguez, Cabo Rojo, Ponce, Juana Diaz, Aguirre, Humacao, Naguabo, Ceiba, Carolina, Caguas, Gurabo, Lares, (H. D. Pratt). Haiti: Carrefor, Cul de Sac, Mariani, Bon Repos, Sept. and Oct., 1924, W. A. Hoffman (Root (10)). Jamaica: Fort Simonds, G. A. Thompson.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the interest and helpful suggestions of Senior Entomologist (R) G. R. Bradley and Sanitary Engineer (R) Porter A. Stephens of the U. S. Public Health Service, during the present study. Capt. Thomas H. G. Aitken and Mr. Jenaro Maldonado Capriles collected some of the material used in the present study and checked the value of taxonomic characters as they were gradually worked out.

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NEW SPECIES OF NEW GUINEA URANOTAENIA OF THE TIBIALIS GROUP[1]
(Diptera: Culicidae)

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The five species of *Uranotaenia* described herein have in common a tuft of hairs or other structure at the tip of the fore tibia in the male, and in this respect resemble *U. tibialis* Taylor, of Australia. In addition, these species all have the following characteristics: male antenna sparsely plumose, the hairs fairly long; proboscis distinctly swollen at tip; head vertex with at least some white scales (bluish white in some lights); scutum dark, with fine dark scales except for a short lateral line of broad white scales in front of wing root; scutellum with broad dark scales; anterior pronotum covered with broad white scales, and a stripe of similar ones across the upper third of the sternopleuron; first fork cell very short (less than half as long as its stem), the scales broad and transparent; mid leg with an enlarged femur and a very long tibia (usually as long as the entire mid tarsus); segment 4 of mid tarsus of male very short, produced thumb-like underneath; segment 5 split apically into two lobes, with two long, slender, simple claws and a prominent empodium, all attached near the middle of the segment; fore tarsus with one claw bent at an angle, the other curved and much broader; hind tarsus white tipped, segments 4 and 5 being entirely white and segment 3 at least partly so; abdominal tergites all dark. The male genitalia are very similar in all five species and without good specific characters. The larva of three species are known and in each head hairs B and C are single thickened bristles, the antenna has two or three blade-like apical appendages and the lateral plates of the 8th abdominal segment are very large, nearly meeting above and below.

Besides differences in the tibial tufts and tarsal hairs, the relative lengths of the fore tarsal segments varies between each of the species, as illustrated in fig. 6.

Outside of the Australasian Region, the writers are aware of only two species (*U. delae* and *U. rayi* of the Philippines) with similar modifications of the fore tibia. These are referred to in connection with our species, *fimbriata*. Two or three other species such as *U. atra* have peculiar modifications of the male tarsi.

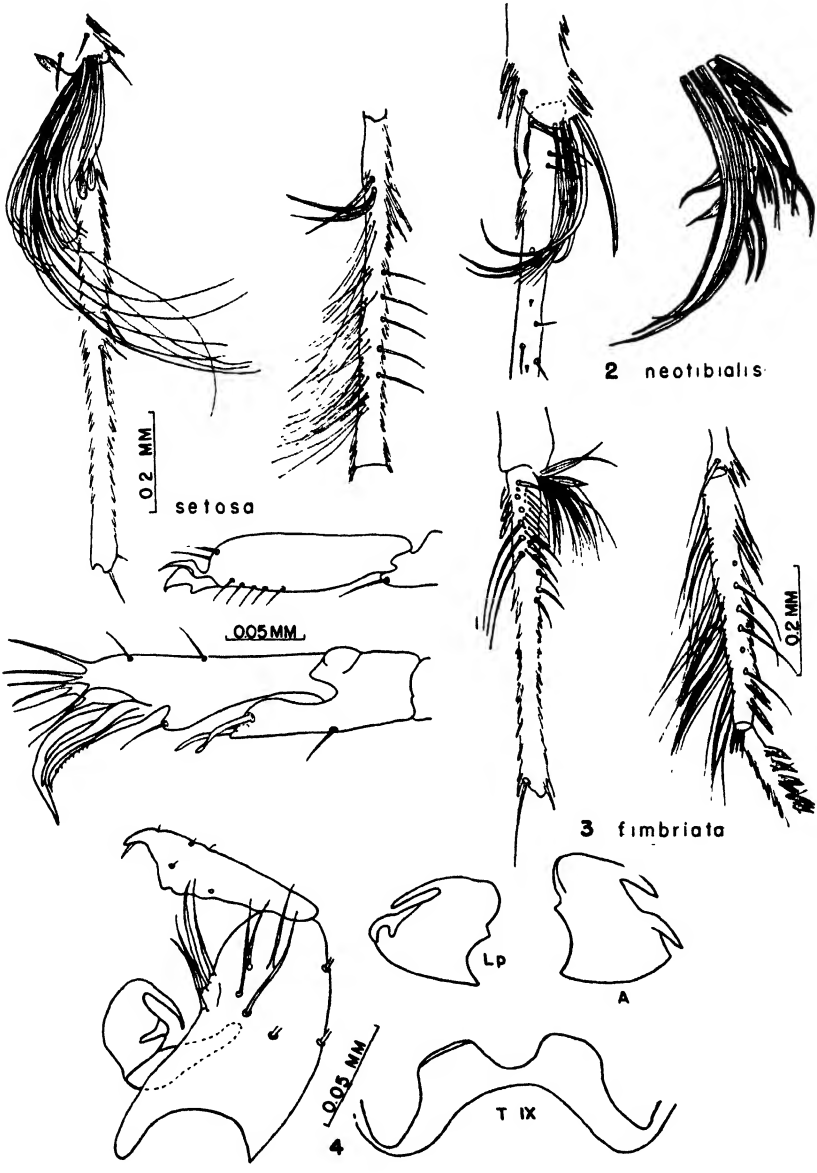
Uranotaenia setosa new species

Male holotype.—Proboscis 1.2 mm., with scattered short hairs on the swollen tip; palpus extremely short; antenna with 8–10 long hairs in each whorl; torus and clypeus dark brown; head (partly denuded) with

[1]From the 19th Medical General Laboratory, U. S. Army, contribution No. 13 from the Entomology-Mammalogy Department.

a median and submedian spot of white scales in front indicating a broad white stripe (paratypes usually with a rather narrow stripe, widening laterally); remainder of head vertex with flat black scales; no upright scales visible (two or three on nape in paratypes). Thorax dark; anterior pronotal lobe with broad white scales; scutum with fine dark scales except for a short prealar line of broad white scales; scutellum denuded (paratypes with flat dark scales); a rather broad stripe of white scales (3–4 scales wide) across sternopleuron. Wing 1.7 mm. Veins 1 and 5 without basal white (present in a single male of this species from Oro Bay); first fork cell less than a half as long as its stem. Fore femur slender. Fore tibia about three-fourths as long as femur, the expanded tip with a prominent tuft (fig. 1) on the outer side consisting of 12 or more very long hairs (nearly as long as the first tarsal segment if straightened out), and more numerous shorter ones, a little more than half as long. First tarsal segment about equal the tibia in length, with a stout bristle at the base, three bristles in a line about the middle of the segment, and two stout bristles and a short hair at apex; segment 2 (fig. 1) about .6 as long as 1, with long, pointed, slightly raised scales and with a fringe of numerous long hairs beginning a short distance from the base and extending nearly to apex (the length of this fringe somewhat variable in the paratypes); opposite these a line of five slender bristles beginning about the middle of the segment; segments 3 to 5 also with long pointed scales; segment 3 a little shorter than 1 and about a third longer than 2, with a ventral row of short hairs, bent at tips; segment 4 two-thirds as long as 3, a few short hairs along ventral side and an apical spine; segment 5 a fifth as long as 4, the claws equal in length but one bent at an angle, the other curved and much broader. Mid femur swollen basally; tibia about half again as long as the femur and twice as long as 1st tarsal; the latter about as long as the remaining four segments, with a double row of minute black thorn-like spines running the entire length of the segment, about eight stout bristles scattered along basal half and four at apex; segments 4 and 5 (fig. 1) very short; segment 4 produced below, with two curved spines at tip; claws of segment 5 long, slender and simple, attached subapically, one a little shorter than the other and about equal the length of the empodium. Segment 1 of hind tarsus slightly shorter than the hind tibia; segments 3–5 together about two-thirds as long as segment 1, pale scaled except for basal third of segment 3, which is darker; 5th segment .4 as long as 4th, the claws short, one a little broader than the other. Abdomen entirely dark above, slightly paler below. *Hypopygium* (fig. 7): Coxite short and broad with four close-set bristles about midway of inner margin, and scattered bristles elsewhere. Style broad, widest toward apex, then abruptly tapered on one side to a point; a few minute hairs on apical half and a pit on the inner margin at the widest point; a small subapical spine. Lateral plate of phallosome wide, with two ventrally directed teeth from the posterior edge, the upper one half as long as the plate, the lower shorter. Ninth tergite with the anterior margin deeply concave, and with two widely rounded posterior lobes, bare of hairs. Eighth tergite with a few bristles along posterior margin.

Female.—Antenna with about six hairs in each whorl, distinctly shorter than in male; first flagellar segment considerably longer than



Legs and genitalia of male: FIG. 1, tip of tibia, segments 1, 2 and 5 of fore tarsus and 4 and 5 of mid tarsus of *U. setosa;* 2, tibial tuft and apical portion of tuft of a second specimen (at higher magnification) of *U. neotibialis;* 3, tibial tuft and segments 1 and 2 of fore tarsus of *U. fimbriata;* 4, coxite, lateral plate of phallosome, and 9th tergite of *U. setosa*, and lateral plate (A) of *U. tibioclada*.

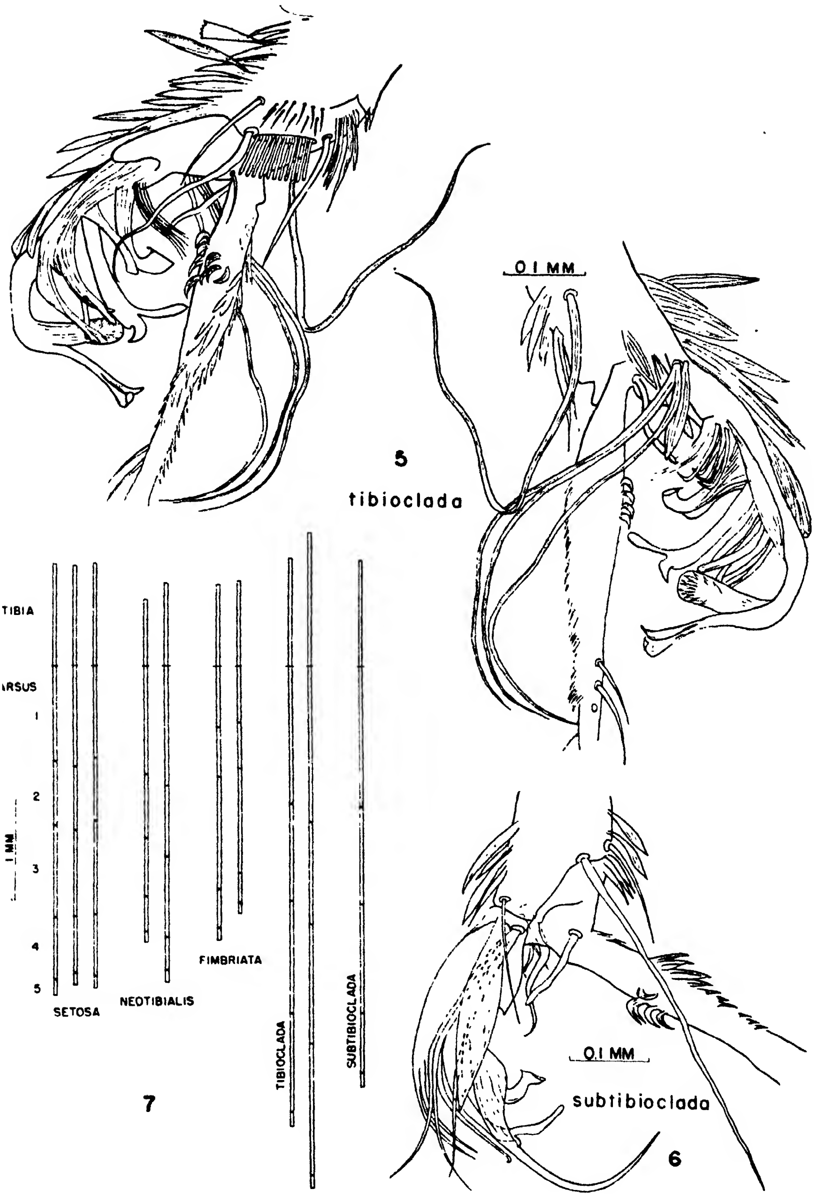
second. Head nearly covered with broad white scales except for a small median area behind; two upright scales visible on nape. Wing with short indistinct lines of pale scales on base of veins 1 and 5. Fore leg normal; the 1st tarsal segment slightly shorter than tibia; first segment of hind tarsus the same; last two segments and apical third of segment 3 of hind tarsus white. Other markings as in male.

Larva (fig. 8).—Antenna short, a few thick spines on shaft and a minute hair near middle; two blade-like leaflets subapically, another leaflet and a heavy spine at apex; preclypeal spine short and stout, set on a slight prominence. Head hair A two-branched, inserted back of antennal base; B and C single bristles, elongate and thick, fringed along sides with minute hairs, C well back of and slightly inside B; *d* a long single hair in line with and internal to B; *e* single, *f* small, with about 5 branches. Upper lateral hair on abdominal segment I and II 3-branched, the lower single; lateral and other hairs on segments III to VII very small. Segment VIII with a large sclerotized plate extending nearly the full length of the segment; from posterior edge of plate a single row of eight stout pointed scales, longest in the middle, each scale fringed laterally except on apical fourth. Pentad hairs 1 and 5 very small, with four or five branches, 2 and 4 single, 3 with five long lightly plumose branches; 1 and 2 set on a small sclerotized plate. Siphon short, index 2.0, the sides parallel, the apical valves very large; pecten of ten wide rounded scales, fringed apically and part way along sides; tuft large, with eight branches. Anal segment elongate, the saddle dorsally as long as siphon, shorter ventrally, its dorsal length a little less than twice its diameter; lateral tuft small, 4-branched; dorsal subcaudal hair with 5 or 6 subequal branches, the ventral hair with 2 longer branches; ventral tuft with 4 or 5 pairs of hairs, the posterior two 2-branched, the anterior single; anal gills slender, a little more than half as long as saddle.

Pupal siphon (fig. 8).—Long and slender (length .58 mm.; width at narrowest point .028 mm.), somewhat flared at tip, pigmented apically and on basal two-fifths.

Holotype.—Male (690–7), with slide mounts of genitalia, legs of one side of body, and larval and pupal skins; reared from larva collected at edge of a sago swamp, Hollandia, Netherlands, New Guinea, 12 Feb., 1945 (H. Hoogstraal and M. Brewer). *Paratypes*.—2 males (690–2, 690–14), 2 females (690–9, 690–6) with larval and pupal skins, and 1 additional slide of a larval and pupal skin (690–8), same collection as holotype; 1 female (932–1) with larval and pupal skins, from a ground pool in a swamp, Hollandia, 2 April, 1945 (H. Hoogstraal); 9 males taken by the writers in light-trap collections at Hollandia on January 21 and 25, April 2, 5, 11, 18, 23, and 26, and May 4, 1945; 1 male from a light-trap collection at Oro Bay, 1944 (17th Malaria Survey Unit). The holotype and part of the paratypes are deposited in the U. S. National Museum.

A number of females from light-trap collections at Hollandia and several reared from larvae (four in Lot 375 from a swamp pool 14 November, 1944, one in lot 1068 from a grassy ditch 5 May, 1945), were tentatively identified as this species. Since they were not directly associated with males and since the female is not known for all members of the group, their positive identification is not feasible.



Legs of male: FIG. 5, tibial appendage (inner and outer aspects) of *U. tibioclada;* 6, tibial appendage of *U. subtibioclada;* 7, relative lengths of fore tibia and tarsal segments of five species (the holotype being represented by the first drawing in each case).

The female of this species is similar to the type of *U. antennalis* Taylor, 1919, but the relation cannot be determined in the absence of the male of the latter. *U. antennalis* may in fact be the female of *U. tibialis* which was described from the same locality (Cairns, Aust.) at the same time. The status of these two species is discussed later.

Uranotaenia neotibialis new species

Male holotype.—Somewhat smaller than *setosa*; proboscis 1.0 mm., wing 1.4 mm. Head vertex with a rather large oval patch of white in front, dark elsewhere. Wing without visible white scales. Stripe of white scales on sternopleuron narrow. Prealar white scales present. Fore tibia about three-fourths as long as femur, with four pairs of spines along the shaft, one moderately long and two shorter bristles and a moderately long tuft at tip; tuft (fig. 2) composed of three dark, flattened, striated, curved, bristles, or modified hairs, about a fifth as long as the first tarsal, a number of hairs (at least one of which is also flattened) a little shorter than the first three, a long pointed scale about three-fourths as long on the outside, and two or three shorter scales. (In one of the paratypes, fig. 2, in addition to the three longest hairs, several of the shorter ones are seen to be flattened and tapered apically, and several others are still wider before the tip and end in a slender filament.) First tarsal 1.6 times as long as tibia; a long bristle at base, three short hairs subbasally, a row of minute thorn-like spines along most of segment, two stout bristles at basal fourth, three spaced along segment beyond this and two at apex. Segment 2 about .6 as long as 1 with two short hairs spaced on apical half and one at apex. Segment 3, slightly longer than 2 with about 5 short hairs spaced along segment and one at apex. Segment 4 about .4 as long as 3, and 5 about .4 as long as 4; tarsus with long, pointed scales. Mid tibia comparatively short for this group, 1.7 times as long as first mid tarsal and about .9 as long as whole tarsus. First hind tarsal a little shorter than tibia; segment 3 all white on one foot, slightly dusky basally on other. (One of paratypes has segment 3 all white, the other two have the basal half dusky but with the dividing lines very indistinct.) *Hypopygium:* very similar to *setosa*.

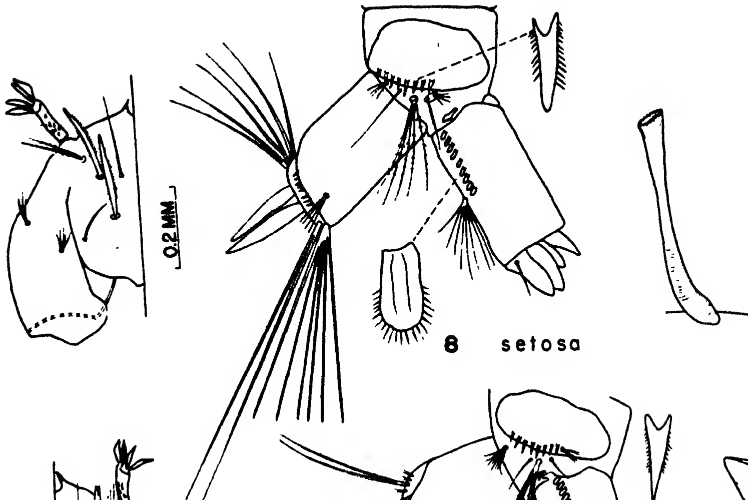
Female.—Unknown.

Larva (fig. 9).—Very similar to *setosa* except as follows: siphon shorter, index about 1.6; pecten with 12 scales, the distal one beyond the insertion of tuft; anal segment also shorter, index of saddle about 1.3, the ventral length less than diameter of saddle; lateral tuft of saddle 7-branched; pentad hair 5, 8-branched; head hair A 2- or 3-branched; hair B on one side forked at tip; abdominal segments III to VII with larger, multiple-branched hair tufts.

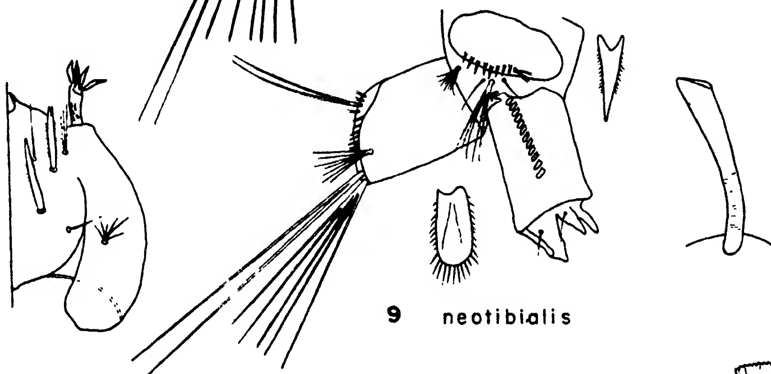
Pupal siphon (fig. 9).—Moderately long, length .46 mm., diameter .043 at narrowest point, pigmented apically and on basal half.

EXPLANATION OF PLATE III

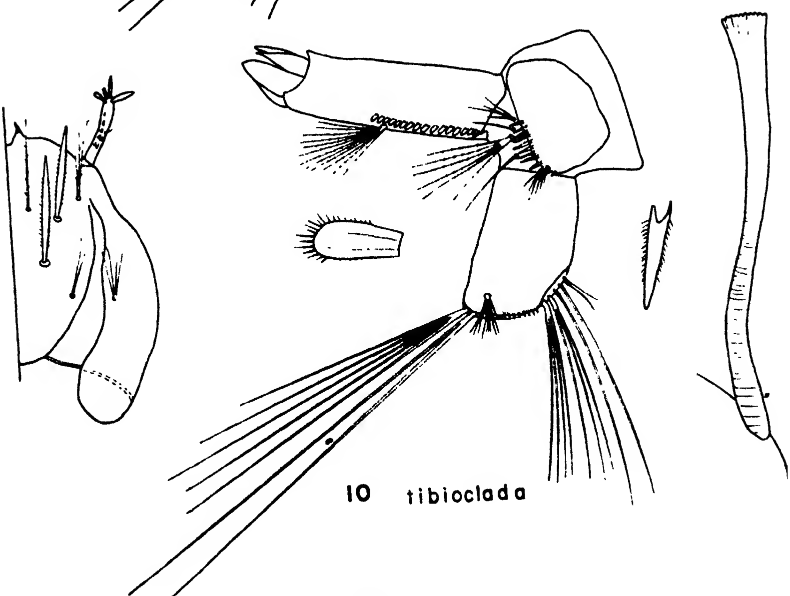
Head and terminal segments of larva and siphon of pupa: FIG. 8, *U. setosa;* 9, *U. neotibialis;* 10, *U. tibioclada.*



8 setosa



9 neotibialis



10 tibioclada

Holotype.—Male (826–1), with slide mounts of larval and pupal skins and one fore leg; reared from larva collected in a swamp ground pool in Hollandia, Netherlands New Guinea, 6 March, 1945 (H. Hoogstraal). *Paratypes.*—1 male (827–3) from another swamp pool at Hollandia 6 March (H. Hoogstraal); 2 males from a light trap at Hollandia, 22 March and 18 April, 1945; 1 slide mount (826–2) of a larval and pupal skin (of which the emerged male has been lost), same lot as holotype.

This species is probably the closest of the ones described herein to *U. tibialis* Taylor, so far as can be recalled by the senior author from a brief examination of the type before the fore leg was lost. The tarsus appeared more or less normal, without a thick fringe on the 2nd segment.

Uranotaenia fimbriata new species

Male holotype.—Proboscis 1.3 mm.; wing 1.5 mm. Head with a narrow line of white around eye margins, produced into a point between the eyes. Prealar white present; stripe on sternopleuron rather narrow; no white on wing. Fore leg characterized by a short tuft of hairs on tibia, a heavy fringe on the 2nd tarsal, very short 1st and 2nd tarsals and a very long 3rd segment. Tibia .7 as long a femur, with about 8 bristles spaced along shaft and a long one (possibly two) at apex; tuft (fig. 3) composed of about 20 short slender hairs, slightly flattened basally, a third as long as the 1st tarsal or a little longer. First tarsal two-thirds as long as tibia, with a row of six long bristles on basal third; opposite these a longer row of about 8 much shorter bristles; between these two a patch of about 20 fine hairs; a long bristle at apex. Second tarsal (fig. 3) .8 as long as first with a heavy fringe of long hairs along one side for nearly entire length (heavier than in *setosa*), the longest distal hairs nearly as long as segment, on opposite side a row of 5 or 6 shorter bristles. Segment 3 as long as 1 and 2 together (nearly equal length of femur); with short raised scales ventrally on basal third and a line of about 20 short slender bristles spaced along the segment. Segment 4 a third as long as 3 and segment 5 about a third as long as 4. Mid tibia equal in length to entire tarsus. Hind tibia a little longer than 1st hind tarsal. Segment 3 of hind tarsus dark on basal half or third, the demarcation from the white fairly distinct. *Hypopygium:* similar to preceding species.

Female and larva unknown.

Holotype.—Male (with slide mount of one fore leg), collected by the authors in a light trap at Hollandia, Netherlands New Guinea, 31 March, 1945. *Paratypes.*—2 males collected in a light trap by the 17th Malaria Survey Unit at Oro Bay, eastern New Guinea, 1945. The type is deposited in the U. S. National Museum.

Uranotaenia delae and *U. reyi* described from the Philippines by Baisis (Philip, Jl. Sc. 57: 68–80, 1935) have similar short tufts of hairs at apex of the fore tibia, and *delae* also has a short 2nd tarsal fringed with rather long hairs. This species, however, is without bristles at the base of the 1st tarsal, while *reyi* does not have the 2nd tarsal fringed and the abdomen has lateral white spots. The types of both these species were said to be females but it seems likely that the author was mistaken

in the sex. A paratype of *reyi* recently examined by the senior author in the U. S. National Museum is a male.

Among a series of specimens examined in the Museum from Bougainville and Guadalcanal, Solomon Islands, the fore legs of the males of one species were found to be very similar to *fimbriata*. The specimens differ, however, in having segment 3 of the hind tarsus entirely white, as well as the tip of segment 2, the white continuing underneath as far as the middle of the segment. The stripe of white on the head is wider (about four scales wide) and short lines of white are visible at the bases of veins 1 and 5.

Uranotaenia tibioclada new species

This and the following species differ from the preceding in the formation of a remarkable structure on the fore tibia, and also in having the fore femur as well as the mid femur enlarged. The specific names given to these species refer to the branched appearance of the tibia.

Male holotype.—A little larger than the preceding species, the legs distinctly longer, the proboscis relatively shorter. Wing 1.7 mm.; proboscis 1.2. Head almost entirely covered with broad white scales; prealar white scales present; none on wings. A narrow stripe of white scales across sternopleuron, continued across mesepimeron as a broad, pruinose, unscaled stripe. Fore femur swollen and similar in appearance to mid femur; fore tibia three-fourths as long as femur, also enlarged more than usual; a few scattered bristles on distal half; arising near the apex from the outer side a long, black, flattened, striated hair, bent sharply at about the middle, more than half as long as the tibia if straightened out; on the opposite side arising near the base of the comb is a moderately long, sinuous bristle and two shorter nearly straight ones. The apical appendage (fig. 4) consists of a semi-rectangular sclerotized basal portion, apparently articulated, from which arise a series of processes, most of which are darkly pigmented and curve back toward the 1st tarsus. These, in sequence, are as follows: a group of 3 long, black, flattened, striated, waved hairs and a pointed scale, attached on the outer side near base, the hairs reaching well beyond the apical process of the appendage; a covering of pointed scales on the lower edge followed by a pair of flattened appressed stems, the apex of one of which is recurved at tip; internal to the base of the latter, a tuft of hairs and a group of about six short bristles with the apical third bent at right angles, a long pointed scale also arises from the base of the bristles; two arms, the basal portions of which appear to be formed of several slender stems, the apical portions fused, one flattened and twisted at tip, the other semi-clubbed; a long smooth arm divided apically into a finger-like portion and a shorter curved beak; several flattened processes of which one is bluntly rounded at tip, three or four are pointed and one has a small tooth subapically; an apical arm divided about midway into a broad, flat, rounded process with a distinct laminated pattern, and two longer, appressed, flattened stems, one broadened and recurved at tip. Segment 1 of fore tarsus a third longer than the tibia, the basal fourth somewhat swollen, with a flattened sinuous bristle from extreme base, a tuft of short pointed scales, curved at tips, subbasally, three long bristles in line near end of the swollen portion, a line of minute thorn-

like spines along the remainder of the segment, and a long bristle at tip; 2nd segment .7 as long as first, with two slender bristles, well separated, near middle and several narrow erect scales and two or three very short bristles beyond these; 3rd segment a little longer than 1st, with three moderate bristles in a line near base and several fine bristles along shaft; 4th segment a little shorter than 3rd (about equal to 2nd) with a line of slender bristles along segment and a heavy one at tip; 5th segment about one-seventh as long as 4th. Mid tibia about twice as long as first mid tarsal, and equal length of entire tarsus; claws of 5th mid tarsal long, subequal, attached about middle of segment; empodium prominent with an unusually coarse fringe. Segment 1 of hind tarsus about equal in length to tibia; segment 3 entirely white. The paratype from a light trap collection at Hollandia is considerably larger than the type (wing 2.5 mm.; proboscis 1.7 mm.). The legs are distinctly longer, fig. 6, but the proportions are similar except that segment 4 of the fore tarsus is slightly longer than segment 3 (instead of slightly shorter). *Hypopygium:* Similar to preceding species; the upper tooth of the lateral plate is somewhat shorter (fig. 7A), reaching only to base of the lower tooth.

Female.—Similar to male except that the antennal hairs are shorter, the fore femur is only slightly widened, tip of tibia triangularly enlarged with a few elongate pointed scales; tarsus normal, the 1st segment as long as tibia.

Larva (fig. 10).—Antenna relatively longer than in preceding species; subapically a narrow blade-like leaflet and a shorter flattened one, at apex a thick bristle and a very short spine. Head hair A, 3-branched; B and C, single, thick; *d* long, single, slender; *e*, long, 2-branched; *f* long, 5-branched. Upper lateral hairs on abdominal segments I and II, 3-branched, the lower single. A large lateral plate on segment VIII with 12 pointed teeth on posterior edge. Siphon index nearly 3.0; pecten with about 16 scales, the last two beyond tuft, each scale wide, rounded and fringed. Anal segment completely ringed by plate, which is about 1.5 times as long as diameter of segment; lateral tuft small, about 8-branched; dorsal subcaudal hair with 5 branches, the ventral one with 2 longer branches; ventral brush with five pairs of hairs, the anterior one with 2 very short branches, the next two single, the last two 3-branched and 4-branched; anal gills missing.

Pupal siphon (fig. 10).—Very long and slender, length 1.05 mm., diameter .05 at narrowest point; pigmented on basal half and at apex.

Holotype.—Male (K156–4) reared from larva collected in ground pool in swamp near Samboga River, Dobodura, Eastern New Guinea, December, 1943 (W. S. Monlux), with slide mounts of terminalia, a fore and mid leg, and the larval and pupal skins. Deposited in U. S. National Museum. *Paratypes* (3 males, 3 females). One male taken by the authors in a light trap at Hollandia, Netherlands New Guinea, 4 February, 1945; 2 males, 3 females in the National Museum collection labeled "New Guinea APO 565, VIII–1–1944. E. S. Ross No. 120," this location being at Toem on the coast about 100 miles west of Hollandia.

The larvae in Lot 156 were associated with Larvae of *Culex* (*Neo-*

culex) caeruleus K. and H., *C.* (*Lophoceraomyia*) *fraudatrix* Theob., and *Uranotaenia* sp.

Uranotaenia subtibioclada new species

Male holotype.—Very similar to *tibioclada* except in the details of the tibial appendage and certain other characters as noted below. Head mostly denuded but the presence of a few scattered pale scales indicates that it may have been largely pale scaled. Proboscis 1.5 mm.; wing 1.8 mm. The most apparent difference in the tibial appendage (fig. 5) is found in the apical arm, the basal portion of which has a large bulbous swelling, while the apical portion extends as a stout curved, tapered rod and is not divided. Other differences from *tibioclada* are as follows: the long hair from near the apex of the tibia and the group of three hairs from the base of the appendage are not more than three-fourths as long; the basal portion of the appendage has a flattened pointed extension on the outer dorsal side; the medial group of bent bristles and tuft of hairs are apparently lacking; on the outside edge are two slender hairs in place of the flattened stems. The tarsal segments are very similar in length and conformation except that segment 4 is much shorter, being only about half as long (.54) as segment 3; the two bristles on segment 2 are placed near the apical third and there are no erect scales on this segment. The last three segments of the hind tarsus are entirely white as in *tibioclada*. *Hypopygium*: appears indistinguishable from *tibioclada*.

Female and larva unknown.

Holotype.—Male collected by the authors in a light trap at Hollandia, Netherlands New Guinea, 21 April, 1945 (with slide mounts of the terminalia and one fore leg). Deposited in the U. S. National Museum.

Uranotaenia tibialis Taylor

Uranotaenia tibialis Taylor, 1919; Proc. Linn. Soc. N. S. W., 43: 839. (Types, one male, two female from Cairns, Queensland, Aust.)

? *Uranotaenia antennalis* Taylor, 1919. Ibid., p. 840. (Two female types, also from Cairns.)

The salient characters given in the original description of the male of *tibialis* were as follows: head white except in center; a short prealar line of bluish white scales; pleura with bluish white flat scales; scutellum brown; abdomen black; apex of fore tibia with a tuft of long, brown, hair-like scales; 2nd tarsal with fairly long scales; hind tarsals 3 to 5 white. In 1944 the type male (No. 72 in the collection of the School of Hygiene and Tropical Medicine, University of Sydney) was removed for examination by Mr. Taylor and the senior author, at which time an accident to the specimen occurred resulting in the loss of the remaining fore and hind legs, before a detailed examination could be made. Neither of us could recall that the 2nd fore tarsal segment had a fringe of hairs, so it is not known whether the reference in the original description to "fairly long scales" referred to hairs or the semi-raised pointed scales found on the tarsi of these species, probably the latter. The specimen showed a median rectangular area of dark scales on the head, white elsewhere, and a few white scales at the base of vein 1. The senior

author's impression is that the species is nearest to *neotibialis* described herein. One of the type females (No. 75) has the hind tarsus all dark, so is not the same species. The hind legs of the second female (No. 77) are missing.

The principal characters given in the description of *U. antennalis* were: head with pale scales in center, blackish elsewhere; antenna brown, basal lobes yellowish, first segment very long, about twice the length of second, its base pale; thorax with a short prealar line of white; pleura brown with white scales; abdomen black, venter brown; apical tarsi pale. In the type female (No. 69, examined by the senior author in 1944) the head is somewhat shrunken but appears nearly all white except for a small dark area behind, the last two segments and tip (about one-fourth) of the third segment of the hind tarsus are pale, there is a broad stripe of white scales across the sternopleuron, and short lines of pale scales on the bases of veins 1 and 5. The long first flagellar segment of the antenna, for which the species was named, is not considered to be of specific value as a long first segment is usual in females of these species. The second female (No. 68) is unmarked except for a large patch of pale scales on the sternopleuron (tarsi and wings all dark, head denuded).

Further material from Cairns will be needed to clarify the taxonomy of these species. When this is done it is possible that one of the species described in the present paper will prove to be the same.

KEY TO MALES

1. Fore tibia with a long, bent hair near tip and a complicated apical appendage from which arise numerous processes, including a group of 3 long, waved hairs; 2nd fore tarsal not fringed; 3rd segment of hind tarsus all white; head scales nearly all white 2
   Fore tibia with an apical tuft of hairs only 3
2. Apical process of tibial appendage a single stout tapered rod with a bulbous base; 4th segment of fore tarsus about half as long as 3rd ...... **subtibioclada**
   Apical process of tibial appendage divided into 3 portions, the shortest one broad, flat and laminated; 4th segment of fore tarsus about as long as 3rd .... **tibioclada**
3. Segment 2 of fore tarsus with a prominent fringe of long hairs; tibial tuft composed of slender hairs; head with a stripe of white around eyes 4
   Segment 2 not fringed with hairs; part of the hairs of tibial tuft distinctly flattened; 1st tarsal segment much longer than tibia and the other tarsals; head with an oval patch of white in front .... **neotibialis**
4. Tibial tuft with some of the hairs nearly as long as the 1st tarsal; the latter longer than segment 3 and nearly as long as the tibia; with a short bristle near base and three in line near middle of segment **setosa**
   Tibial tuft with all the hairs short; tarsal segment 1 and 2 very short, the two together no longer than segment 3, which is unusually long (longer than tibia); 1st tarsal with a line of 6 long bristles near base, a second line opposite of shorter ones, and a patch of fine hairs in between...... **fimbriata**

AN ECTOPARASITIC SURVEY OF MAMMALS FROM LAVACA COUNTY, TEXAS

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Maxcy (1926) first noted that rats and mice might be the reservoir of endemic typhus, and that fleas, mites, or ticks, were probable transmitters of the disease in the United States. Since that time, many investigators have recovered the rickettsiae of typhus fever from rats and their fleas. Dyar, Rumreich, and Badger (1931) first demonstrated the natural infection of the rat fleas, *Xenopsylla cheopis* (Rothschild) and *Leptopsylla segnis* (Schonheer) with endemic typhus. The fleas were taken from rats trapped in Baltimore, Md., and Savannah, Ga. Brigham (1941) reported the recovery of endemic typhus fever rickettsiae from naturally infected chicken fleas. Alicata (1942) obtained experimental transmission of the typhus rickettsiae from rat to rat with the sticktight flea, *Echidnophaga gallinacea* (Westwood). Dove and Shelmire (1932) reported the laboratory transmission of endemic typhus from guinea pig to guinea pig through the bites of tropical rat mites, *Liponyssus bacoti* (Hirst). Mooser, Zinsner, and Castaneda, working in Mexico City in 1930, obtained transmission from rat to rat by the rat louse, *Polyplax spinulosa* (Burmeister).

Due to the prevalence of typhus fever in south Texas an intensive murine typhus research program has been conducted since January, 1945, in Lavaca County, Texas. The Texas State Department of Health and the United States Public Health Service have been attempting to complete the epidemiological picture of murine typhus. Specialists trained in epidemiology, entomology, bacteriology, and mammalogy have been concerned with various aspects of the program.

This report concerns the results of an ectoparasitic survey of the mammals of Lavaca County, Texas.

The majority of the larger animals were taken by a trapper loaned to the program by the United States Fish and Wildlife Service. Dr. W. B. Davis, Texas A. & M. College Fish and Game Department, trapped and identified many of the rodents. All other specimens were trapped by personnel directly assigned to the typhus research program by the two cooperating agencies. All animals were taken alive, brought to the laboratory and bled. The ectoparasites were then removed, identified, and frozen under glass seal for laboratory animal innoculation.

Assistance was given in the identification of the ectoparasites by personnel of the United States National Museum, Washington, D. C., and the Rocky Mountain Spotted Fever Laboratory, Hamilton, Montana.

[1]The assistance of the following personnel of the Texas State Department of Health Laboratory is gratefully acknowledged: Frances Willard, Kellie O'Neill, E. G. Batte, and J. H. Sikes.

Class **Mammalia**

Order **Marsupialia**

Opossum—*Didelphis virginiana* subsp. Twenty-seven examined.

SIPHONAPTERA

Orchopeas howardii (Baker)
Rhopalopsyllus coxi Eads
Ctenocephalides felis (Bouché)
Echidnophaga gallinacea (Westwood)
Pulex irritans Linnaeus
Xenopsylla cheopis (Rothschild)

ACARINA

Eulaelaps stabularis (Koch)
Liponyssus bacoti (Hirst)
Ixodes scapularis Say

Order **Carnivora**

Texas Raccoon—*Procyon lotor fuscipes* Mearns. Thirteen examined.

SIPHONAPTERA

Rhopalopsyllus coxi Eads
Pulex irritans Linnaeus
Hoplopsyllus affinis (Baker)
Orchopeas howardii (Baker)
Cediopsylla simplex (Baker)
Echidnophaga gallinacea (Westwood)

ACARINA

Ixodes scapularis Say
Amblyomma americanum (Linnaeus)
Ixodes hearlei Gregson
Ixodes banksi Bishopp

MALLOPHAGA

Suricatoecus octomaculatus (Paine)

Striped Skunk—*Mephitis mesomelas mesomelas* Lichtenstein. Three examined.

SIPHONAPTERA

Pulex irritans Linnaeus

MALLOPHAGA

Suricatoecus octomaculatus (Paine)

Grey Fox—*Urocyon cinereoargenteus* subsp. Sixteen examined.

SIPHONAPTERA

Ctenocephalides canis (Curtis)
Echidnophaga gallinacea (Westwood)
Pulex irritans Linnaeus
Orchopeas howardii (Baker)
Rhopalopsyllus coxi Eads
Hoplopsyllus affinis (Baker)
Cediopsylla simplex (Baker)

ACARINA

Amblyomma americanum (Linnaeus)
Dermacentor variabilis (Say)
Ixodes scapularis Say

Texas Red Wolf—*Canis rufus* (Audubon and Bachman). Four examined.

SIPHONAPTERA

Pulex irritans Linnaeus
Echidnophaga gallinacea (Westwood)
Rhopalopsyllus coxi Eads

ACARINA

Ixodes scapularis Say
Amblyomma americanum (Linnaeus)

Domestic Dog—*Canis familiaris*. One hundred and thirty-two examined.

SIPHONAPTERA
Pulex irritans Linnaeus
Ctenocephalides canis (Curtis)
Ctenophalides felis (Bouché)

MALLOPHAGA
Trichodectes canis Degeer

ACARINA
Amblyomma americanum (Linnaeus)
Amblyomma maculatum Koch
Dermacentor variabilis (Say)
Rhipicephalus sanguineus Latreille

Domestic Cat—*Felis domestica*. Ninety-five examined.

SIPHONAPTERA
Echidnophaga gallinacea (Westwood)
Ctenocephalides felis (Bouché)
Leptopsylla segnis (Schonherr)
Xenopsylla cheopis (Rothschild)

Order **Rodentia**

Texas Pocket Gopher—*Geomys texensis* Merriam. Seven examined.

MALLOPHAGA
Geomydoecus geomydis (Osborn)

ACARINA
Atricholaelaps sigmodoni Strandtmann

Fox Squirrel—*Sciurus niger limitis* (Baird). Sixteen examined.
Grey Squirrel—*Sciurus carolinensis* subsp.

SIPHONAPTERA
Orchopeas howardii (Baker)

ANOPLURA
Neohaematopinus sciurinus (Mjoberg)
Hoplopleura sciuricola Ferris

ACARINA
Amblyomma americanum (Linnaeus)
Ixodes scapularis Say
Atricholaelaps sigmodoni Strandtmann

Field Mice—*Baiomys taylori* subsp. One hundred and forty-seven examined.
Peromyscus leucopus texanus (Woodhouse). Twenty-three examined.
Perognathus sp. Two examined.

SIPHONAPTERA
Trichopsylla ironsi Eads[2]

ACARINA
Amblyomma americanum (Linnaeus)
Ixodes sp.
Eulaelaps stabularis (Koch)
Atricholaelaps sigmodoni Strandtmann

Cotton Rat—*Sigmodon hispidus texianus* (Audubon and Bachman). Ninety-four examined.

ANOPLURA
Hoplopleura hirsuta Ferris

ACARINA
Atricholaelaps sigmodoni Strandtmann
Ichoronyssus sp.
Liponyssus bacoti (Hirst)
Amblyomma americanum (Linnaeus)

[2]Description of species accepted for publication by Annals of the Entomological Society of America.

Wood Rat—*Neotoma floridana* subsp. Thirteen examined.

ANOPLURA

Hoplopleura hirsuta Ferris

ACARINA

Liponyssus bacoti (Hirst)
Amblyomma americanum (Linnaeus)
Atricholaelaps sigmodoni Strandtmann
Haemaphysalis leporis-palustris Packard

House Mouse—*Mus musculus musculus* Linnaeus. One hundred and fifty-five examined.

SIPHONAPTERA

Leptopsylla segnis (Schonherr)
Xenopsylla cheopis (Rothschild)
Echidnophaga gallinacea (Westwood)

ANOPLURA

Polyplax spinulosa (Burmeister)

ACARINA

Liponyssus bacoti (Hirst)

Domestic Rat—*Rattus rattus* subsp. Seven hundred and fifty-three examined.

SIPHONAPTERA

Pulex irritans Linnaeus
Nosopsyllus fasciatus (Bosc)
Echidnophaga gallinacea (Westwood)
Xenopsylla cheopis (Rothschild)
Leptopsylla segnis (Schonherr)
Ctenocephalides felis (Bouché)
Ctenocephalides canis (Curtis)

ACARINA

Liponyseus bacoti (Hirst)
Laelaps hawaiiensis Ewing
Eulaelaps stabularis (Koch)
Echidnolaelaps echidninus (Berlese)
Dermanyssus gallinae Redi
Ixodes sp.

ANOPLURA

Polyplax spinulosa (Burmeister)

Texas Cottontail—*Sylvilagus floridanus* subsp. Seven examined.

SIPHONAPTERA

Hoplopsyllus affinis (Baker)
Echidnophaga gallinacea (Westwood)

ACARINA

Haemaphysalis leporis-palustris Packard
Echinolaelaps echidninus (Berlese)
Listrophorus sp.
Atricholaelaps sigmodoni Strandtmann

Order **Artiodactyla**

White-Tailed Deer—*Odocoileus virginianus* subsp. Two examined.

DIPTERA

Melophagus ovinus Linnaeus

ACARINA

Amblyomma americanum (Linnaeus)
Ixodes scapularis Say

Order **Xenarthra**

Texas Armadillo—*Dasypus novencinctus texanus* (Bailey). Three examined.

SIPHONAPTERA

Rhopalopsyllus coxi Eads

Order **Chiroptera**

Mexican Free-Tailed Rat—*Tadarida mexicana* (Saussure). Thirty-four examined.

SIPHONAPTERA	ACARINA
Sternopsylla sp.	*Chiroptonyssus texensis* Augustson
	Ornithodoros sp.

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THE SALTICIDAE (SPIDERS) OF PANAMA, by ARTHUR M. CHICKERING. Bull. Mus. Comp. Zool., Harvard College, 97, pp. 1-474, 432 figs., 1946.

Dr. Chickering's monumental volume on Salticidae of Panama is a milestone in the study of the American faunas. Based on material he collected in Panama, this paper on "jumping spiders" (formerly Attidae) adds eighty species and fourteen genera to the known number of species from that country. Both the new material and many heretofore inadequately known species are described in detail and illustrated with line drawings. The descriptions are well arranged and documented with measurements, spination of legs, and color of specimens in alcohol. The general arachnologist would find the work easier to follow had complete documentation of synonomic references been included as well. Keys to species, genera, and groups of genera aid in placing spiders of the family.

It is hoped that Dr. Chickering will supplement his excellent systematic monograph with an analysis of the ecological and zoogeographical relationships of the Salticidae of Panama.—HARRIET EXLINE FRIZZELL.

BIOLOGY OF A PEST MOSQUITO COMMON IN NEW GUINEA[1]

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Among the more important mosquitoes affecting the health of natives and newcomer alike in New Guinea and adjacent islands is *Aedes scutellaris scutellaris* (Walker). Its characteristics as a pest alone class this as a mosquito of importance. The fact that this is a bold and persistent feeder during daylight causes it to be noticed more than other furtive species that feed after dark. This mosquito was especially annoying at army installations during the early stages of construction and was always a greater or lesser problem as the amount of rainfall was more or less. Opportunity to study this species was afforded at Oro Bay, New Guinea, and near Bosnek, Biak, in the Schouten Group during 1944 and 1945.[2]

RANGE AND HABITAT

Aedes scutellaris scutellaris[3] is widely distributed over New Guinea and adjacent islands. In the course of these observations it was collected at Milne Bay, Oro Bay, and Hollandia, all on the north shore of the main island and on Biak. The general distribution of the species in this group has been discussed by Farner and Bohart (1945) and by Stone and Farner (1945).

Frequent and numerous field collections show that *Aedes scutellaris scutellaris*, like others of the subgenus, *Stegomyia*, develops largely in small containers of water. Holes in trees and fallen plant parts, especially large leaves of forest trees, provide larval sites under natural conditions. Artificial containers such as cartons, coconut hulls, discarded shoes, tires, barrels, cans, gutters and canoes provide additional larval sites near human habitation. These and even more extensive larval sites are present in army camps. Huge piles of boxed parts for aeroplanes in a supply dump on Biak gave rise to one very annoying outbreak of this mosquito. Another outbreak on the same island came from an exposed dump of several thousand salvage tires. An unexpected source of a minor outbreak was bilge water in the hulls of amphibious

[1]Research Paper No. 818, Journal Series, University of Arkansas. Published with permission of the Director of the Arkansas Agricultural Experiment Station.

[2]Authors and assistants were members of the 17th Malaria Survey Detachment, Army of the United States, at the time these observations were made.

[3]*A. variegatus* (Dol.) is a common synonym. The New-Guinea subspecies is said to be identical with *A. scutellaris hebrideus* of New Hebrides and is sometimes referred to under this name. Whether the correct name for the New-Guinea subspecies is *scutellaris* or *zonatipes* (Walker) has not been determined with certainty. Recent studies of the Australasian species of this group have been published by Farner and Bohart (1945) and Stone and Farner (1945).

aircraft. No larvae were found in cans or bottles with narrowly constricted tops.

Certain kinds of artificial containers were found to be preferred for larval sites as was shown by examination of 236 naturally infested ones removed from rubbish dumps. Paper cartons contained an average number of 74 larvae each while metal containers had an average number of 43 larvae each. Variation existed in suitability of different metal containers also. Those that were lined with lacquer had an average number of 63 larvae each while those that had been blackened by burning had only 32 larvae to the average can. This contrast in suitability of cans for larval sites was further demonstrated by a test with selected cans. The test consisted of four 12-ounce cans with lacquer linings, four without linings and four of each that had been heated to a dull red glow in an open fire. The 16 cans were partly filled with water and placed in the edge of a woods where they were examined and larvae removed once each week. At the expiration of a 63-day interval, 300 larvae had been removed from the four cans with lacquer linings, 94 larvae had been taken from the unlined cans, and only one larva had been found in the eight burned cans.

LIFE HISTORY

General.—*Aedes scutellaris scutellaris* has about the same general life history as other members of the subgenus, *Stegomyia.* Eggs are deposited singly on water or suitable moist surfaces. Often eggs adhere to the walls or debris where they may remain in a viable state weeks or possibly months. Larvae spend much of their time cruising along sticks, walls or debris raking the surfaces with their mouth bristles in order to dislodge minute particles of food. Larvae grow rapidly and are ready to pupate in about a week. Adults usually feed several times during their normal span of two or more weeks.

Egg Stage.—Eggs of this species are shiny black, about 0.75 mm. long and slightly less than half as much in diameter. They float readily on the surface film but will sink when wet.

The egg stage showed considerable variation in duration of incubation period for several groups treated in the laboratory. Those kept continuously on or in water from the time they were deposited required from two to 21 days for incubation, and the mean duration was 5.0 ± 0.3 days for 849 eggs as is shown in Table I. Eggs laid on moist surfaces did not hatch until flooded. One group was viable after 61 days in a moist chamber. In order for eggs to remain viable so long they must have been incubated on a wet surface long enough for the embryo to develop to the hatching stage. Examination of 84 eggs one to four days old showed that most embryos had the external features developed within 48 hours after deposition. By the end of the third day all seemed to be fully formed.

Larval Stage.—Superficially a larva of *A. scutellaris scutellaris* resembles those of other *Stegomyia.* It is slender with distinct constrictions between abdominal segments, and, in an active larva, the thorax is only slightly greater in width and depth than the abdominal segments. A larva moves more by rhythmic undulations than by rapid

convulsive jerks characteristic of less tenuous larvae. At rest at the surface a larva is suspended nearly vertically from its short broad siphon. When disturbed it will wriggle rapidly to the bottom where it will secrete itself in any debris present. Larvae shun strong light and will usually rest on the darker side of a container exposed to such light.

Larvae reared in the laboratory, where the temperature ranged between 75 and 90 degrees Fahrenheit, required four to eight days and a mean of 5.2 ± 0.1 days for completion as is shown in Table I. The mean duration of each of the first three instars was slightly over one day; the fourth instar required two days on the average.

Pupal Stage.—The pupal stage required one to three days and a mean of 2.0 ± 0.1 days when reared in the laboratory. Under field conditions this was often shortened to one day in large containers exposed to direct sun.

TABLE I

Duration of Immature Stages of *Aedes scutellaris scutellaris* in Laboratory, Biak, Netherlands East Indies, 1944

Stage	Number	Duration		
		Maximum	Minimum	Mean
		Days	*Days*	*Days*
Egg	849	21	2	5.0 ± 0.3[4]
First instar	356	2	1	1.0 ± 0.1
Second instar	356	3	1	1.1 ± 0.1
Third instar	356	3	1	1.1 ± 0.1
Fourth instar	356	4	1	2.0 ± 0.1
Larval stage	356	8	4	5.2 ± 0.1
Pupa	356	3	1	2.0 ± 0.1
Larva and pupa total	356	10	6	7.2 ± 0.1

[4]Standard Error.

Adult Stage.—Adults may be observed in the woods near their larval sources almost any time during the day. They are especially active and eager to feed early in the morning and late in the afternoon. Both males and females may be active at such times. Males have been observed to hover in sunlit spots in the woods. As the females approached to feed they would be seized by the males and mating followed. Females intent on feeding approached boldly and were deliberate in choosing feeding sites. Exposed parts of the body or parts bound tightly by clothing were especially suitable feeding sites. Females tended to feed in greater numbers in absence of wind, but even moderate breezes would not prevent feeding. However, strong wind drove the pests to cover.

Adults live as long as six weeks in the laboratory. The mean longevity for 33 females was 21.9 ± 1.5 days in cages where an opportunity to feed was afforded daily. Mating took place usually on the first or second day after emergence. The preoviposition period was about seven days but was extended to 25 days in one case. From

one to seven batches of eggs or a mean of 86 ± 9 eggs were laid by each of these mosquitoes. One female deposited 218 eggs in 20 days. The mean number of blood meals consumed was 10.4 or nearly one meal every two days.

Females may lay eggs in a meniscus about an emergent or floating object or about the margin at or above the water level. Caged females provided with a bowl lined with filter paper laid most of the eggs on the moist paper above the meniscus. Two were observed ovipositing late in the afternoon in an exposed bowl containing slightly foul water and moist pellets of mud just above the water line. Both of them laid their eggs in the moist mud. Other eggs laid previously were placed in some marginal floating debris.

The effective flight range of this mosquito is not known exactly, but it seems to be less than three-quarters mile normally. Observation on relation between annoyance in camps and larval sites showed that the normal flight is less than 800 yards. For instance, personnel of one isolated unit on Biak was much annoyed by an outbreak arising from mountainous piles of boxes in a nearby supply dump. The pests were most abundant in the tents on the near side of the camp and within 100 yards of the source. Personnel stationed on the far side of the camp and no more than 800 yards from the source, reported no annoyance. Another instance is that of two small units separated by about 800 yards. Personnel of one was greatly annoyed by an outbreak arising from a small dump of discarded paper ammunition cartons in the unit area. Personnel of the farther camp reported no annoyance.

Actual observed range of individual mosquitoes was at least 1500 feet. A total of 5757 stained mosquitoes were released at intervals of 500 feet from retrieving stations on Biak between 31 December, 1944, and 22 January, 1945. Different stains applied as powdered dye diluted with flour were used to mark mosquitoes released at each of four places. Releases were made one or more times each day, according to the rate of emergence in the laboratory. Retrieving stations consisting of one man in a tent or peripheral woods nearer points of release than other sources of human blood were operated daily between 4:45 and 5:45 P. M. All mosquitoes attracted to the collector were caught in killing tubes for later examination. Collected specimens were placed on dry white filter paper in a petri dish and were moistened with a drop of 95 per cent alcohol. Any particle of stain present was dissolved and absorbed on the filter paper as a diffused spot below the mosquito that had borne it. Mosquitoes were retrieved from all points of release from zero to 1500 feet distant. Two were retrieved from 2737 specimens released at the 1500-foot point on the sixth and ninth days after the last releases were made.

SUMMARY

1. One of the most annoying pest mosquitoes in New Guinea and adjacent islands is *Aedes scutellaris scutellaris* (Walker). It is a sylvan species that is adaptable to domestic conditions. Larval sources include collections of water in plant parts and artificial containers. Exposed supply and salvage dumps about army camps provide abundant

larval sites. Bilge water in the hulls of amphibious aircraft provided one unusual source.

2. Metal containers varied in suitability as larval sites. Those with lacquer linings were more important than those without. Prior burning of metal containers made them decidedly less desirable as larval sites.

3. Developmental stages required for completion a little less than two weeks on the average. Egg stage and larval stage each required about five days, and the pupal stage required about two days. The egg stage was prolonged 61 days in the laboratory by keeping eggs in a moist chamber before submersion.

4. Adults are local in habits and tend to remain in the vicinity of their larval sites. Marked females have been collected 500 yards from point of release, but annoying numbers did not travel 800 yards as was observed in two different areas. Moderate breezes do not prevent feeding, but strong ones keep the mosquitoes from coming out.

5. Adults may live six weeks in the laboratory. Several batches of eggs may be laid by one female, and the mean number of eggs was 84 ± 9 for caged females. Eggs are laid in a meniscus about emergent or floating objects, or they may be laid on moist surfaces above water level.

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DISPERSION OF SMALL ORGANISMS, DISTANCE DISPERSION RATES OF BACTERIA, SPORES, SEEDS, POLLEN, AND INSECTS; INCIDENCE RATES OF DISEASES AND INJURIES, by D. O. WOLFENBARGER. Reprinted from The American Midland Naturalist, Vol. 35, No. 1, pages 1–152, January, 1946. The University Press, Notre Dame, Indiana. Price $1.00.

It is a satisfaction to read such a thorough and scholarly discussion of a subject with which all biologists must be concerned and about which most of them probably know very little. Following a brief introduction devoted chiefly to the definition of terms and description of methods the article is divided into two main sections, one of 102 pages on dispersion and incidence rates and the other on generalizations which completes the article with the exception of a brief appendix, nine pages of bibliography and an index. The first section includes discussions of large numbers of specific examples abundantly illustrated with graphs. Some reduce familiar conjectures to a scientific basis while others introduce striking data at variance with what might have been expected. The perusal of these records is to be recommended heartily. The author's analysis and discussion of the data in the second part of the article distinguishes between migration and dispersion and considers very thoroughly the factors involved in true dispersion. It is too compactly written to be summarized in a brief review, but the entire study is worthy of a place in the library of all biologists—and not merely of shelf room but of careful reading. Since a large number of the specific organisms considered are insects the work will be especially interesting to entomologists.—A. W. L.

NEW HEPTAGENINE MAYFLIES

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This paper presents descriptions of five new species of mayflies belonging to the subfamily Heptageniinae. Three of these species are from Illinois, one from Indiana, and one from Maine. They were segregated from material in the collection of the Natural History Survey; all the types are deposited in the Survey collection. The types of most of the previously described species, which are mentioned in comparing and differentiating these new species, were studied in 1942. Study of these types was made possible by travel funds supplied by the Illinois Natural History Survey.

Genus **Iron** Eaton

Iron namatus new species

Male.—Length of body 9–11 mm., of wing 9–11 mm. General color light brown, with light yellowish-brown or dark brown markings. A member of the ***longimanus*** group of species. See McDunnough (1938) for notes on the synonymy of the species in this group.

Head yellowish-brown, with variable obscure darker shading between lateral ocelli and antennal bases, and on vertex just dorsal to ocelli; frontal shelf obscurely darkened on meson; antennae tan, darkened at base of flagellum; ocelli black at bases; compound eyes pearl gray, contiguous on meson. Thoracic notum brown, light yellowish-brown at lateral margins, apices of meso- and metanota dark brown except on meson at apices of meso- and metascutella; pleura and sternum brown; mesonotum darkened at anterior margin, and a narrow, oblique, dark brown line on pleuron anterior to base of fore-wing. Pronotum brown, darker at posterior margin on meson, a short, oblique dark brown line present at each lateral margin; foreleg light brown, a dark brown median spot on femur, and minute dark brown area at base of femur, apex of tibia, and at each tarsal articulation; relative proportions of parts of foreleg; femur 30, tibia 40, first tarsal segment 18, second 16, third 16, fourth 11, fifth 6. Wings hyaline, veins light brown, crossveins in costal interspace wanting at base, weak and incomplete in midregion, well developed in stigmatic area, these costal crossveins almost hyaline, slightly milky; other crossveins in fore- and hindwing light brown; stigmatic crossveins slanted, not anastomosed. Middle and hind legs light brown, conspicuous dark brown median spot on femora. Abdominal tergites dark brown, lighter near anterior margin, so as to give abdomen an annulated appearance; antero-lateral angles light yellowish-brown. Sternites light brown, darkened at posterior margins. Apical abdominal tergites yellowish-brown, dark brown at posterior margins. Genitalia brown, forceps gray-brown; tails uniformly very dark gray-brown, almost black. Penis lobes, fig. 3, with relatively small, weak median spines, apical

notch of each penis lobe narrow, shallow; projection on inner, mesal margin of penis lobes rounded.

Female.—Length of body 9–11 mm., of wing 11–13 mm. Generally slightly lighter in color than male, with brown of male replaced by yellowish-brown, and light yellowish-brown areas of male becoming almost white in female. Abdomen only faintly annulated, rather uniformly light brown. Legs, wings, and tails colored as in male. Terminal abdominal sternites shown in fig. 8.

Nymph.—Length of body of mature specimens 8–11 mm. Dorsal view, fig. 1. Dorsum of abdomen almost unicolorous, but with a pair of slightly darker sub-median dots and a faint band at posterior margins of tergites. Sternites seven and eight each with a pair of round, sub-basal spots, ninth sternite with a dark line at anterior and lateral margins. Gills relatively small for genus, and first and last pairs showing no tendency to converge beneath body.

Holotype, male.—Leonard Springs, near Bloomington, Indiana, April 25, 1946, W. E. Ricker et al. Specimen dry, on pin. *Allotype, female.*—Same data as for holotype. Specimen dry, on pin. *Paratypes.*—Indiana: Same data as for holotype, 10 ♂, 5 ♀ : 7 ♂, 4 ♀ dry, on pins; 3 ♂, 1 ♀ in alcohol; genitalia of 3 ♂ on microscope slides.

Nymphs.—Nymphal material of this species was collected at the following localities, all in Southern Indiana: Leonard Springs, near Bloomington, April 25, 1946, and March 14, 1945; May's Cave, near Bloomington, April 25, 1946; Speed Hollow, Springville, April 26, 1946. All nymphs collected near outlets of springs.

This species is most closely related to *Iron pleuralis* Banks, but differs in having the median spines of the penis lobes short and weak, rather than long and stout; the notch in the apical margin of each penis lobe is, also, shallower and narrower in *namatus* than in *pleuralis*. The apical margin of the forceps base in *pleuralis* is emarginate on the meson, but entire in *namatus*. From *fragilis* Morgan, *namatus* may be distinguished by its larger size and differently colored abdominal tergites.

Iron frisoni new species

Male.—Length of body 8 mm., of wing 9 mm. General color very light yellowish-tan, with thorax darker. A member of the *longimanus* group of species.

Head light yellowish, unmarked; ocelli black at bases; compound eyes contiguous on meson, grayish-brown, darker ventrad; antennae tan. Thorax uniformly light golden-brown, apices of meso- and metanota darker brown, lateral suture anterior to wing bases, and pleural suture ventral to wing bases, edged with a narrow, dark brown line; pronotum unmarked; foreleg light yellowish, femur with a dark brown mesal spot, narrow area at apex of tibia and apical tarsal segment slightly darkened; relative proportions of parts of foreleg: femur 23, tibia 34, first tarsal segment 11, second 12, third 10, fourth 8, fifth 4. Wings hyaline, veins C and Sc and humeral crossvein faintly brown tinted, other veins and crossveins colorless; costal crossveins in stigmatic area not slanting, nor anastomosed; stigmatic area of wing opaque, milky; costal crossveins wanting at base, weak and incomplete in mid-

region, well-marked in stigmatic area. Abdomen very light yellowish-tan, almost cream colored; tergites faintly brown tinted at posterior margins; sternites unmarked; apical abdominal tergites light tan; genitalia tan, penis lobes, fig. 4, with mesal hooks long, slender, and

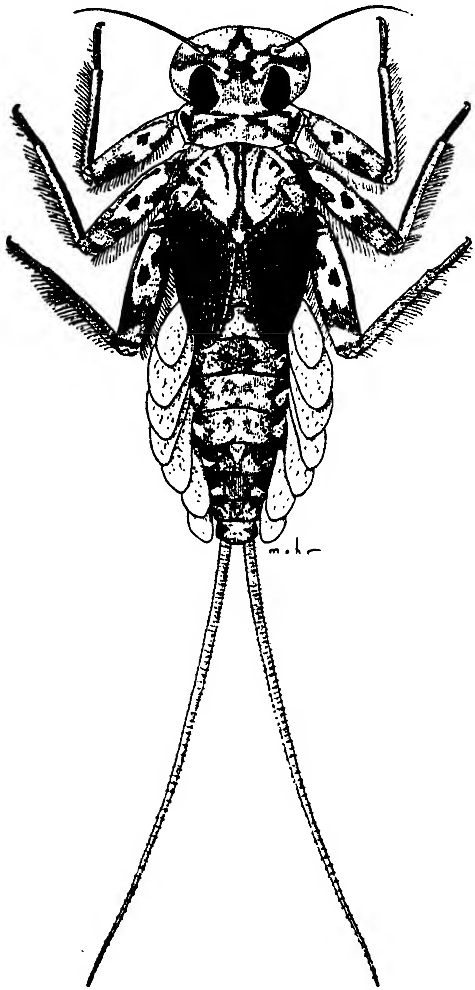


FIG. 1. *Iron namatus*, nymph, dorsal aspect.

with a deep apical notch, apical margin of forceps base dome-shaped, bluntly angled on meson.

Holotype, male.—Mt. Katahdin, Maine, Roaring Brooks, August 26, 1939, T. H. Frison. Specimen in alcohol; genitalia on microscope slide.

The fact that the first tarsal segment of the foreleg is slightly shorter than the second would seem to indicate that this species belongs in the genera *Cinygma* or *Cinygmula*. The type of genitalia, the lack of basal costal crossveins, and the fact that the stigmatic crossveins are not anastomosed, however, refer it to *Iron*. The structure of the genitalia in *frisoni* is closest to that of *longimanus* Eaton, but differs in that the median hooks are longer and more slender, and the penis lobes each have an apical notch; this notch is wanting in *longimanus*. The acutely angled projection on the inner, mesal margin of each of the penis lobes distinguishes this species, also, from *pleuralis* Banks or *fragilis* Morgan.

Genus **Heptagenia** Walsh

Heptagenia diabasia new species

Male.—Length of body 9–13 mm., of wing 8–12 mm. General color light yellow, with darker areas shaded with golden or light reddish-brown. A member of the *elegantula* group of species.

Head light yellowish, with a minute black dot at base of frontal shelf at either compound eye margin; vertex with a vague black spot on meson and diffuse reddish-brown shading just posterior to ocelli. Antennae yellowish; ocelli greenish-gray at bases. Compound eyes pearl gray, separated on meson by a space slightly less than width of median ocellus. Thorax yellowish or cream colored, shading to golden-brown on dorsal meson. Posterodorsal margin of pronotum and posterior margins of meso- and metanota shaded with dark brown; faint, light reddish-brown streaks at lateral margins of mesonotum, and on pleuron dorsal to meso- and metacoxae; meso- and metacoxal sutures, oblique pleural stripe anterior to metacoxa, minute spot on pleuron at base of forewing, and spot just dorsal to metacoxa, black or very dark brown. Foreleg yellowish, with reddish-brown shading on middle and at apex of femur, and at base of tibia; apex of tibia, and tarsal segments at articulations, dark brown; fifth tarsal segment entirely brown; relative proportions of parts of foreleg: femur 35, tibia 43, first tarsal segment 4, second 16, third 14, fourth 10, fifth 5. Wings hyaline, all veins and crossveins light brown; costal and subcostal crossveins slightly thickened, costal crossveins in stigmatic area slanted, occasional veins anastomosed; stigmatic area slightly milky, opaque. Middle and hindlegs yellowish, mesofemur reddish-brown at middle and at apex, metafemur reddish-brown at apex only; minute brown marks at articulations of tarsal segments, with fifth segment completely brown. Abdomen yellowish, posterior margin of each tergite with a narrow, transverse, black line. A black lateral, spiracular hair line extends full length of abdomen, with minute black hair lines extending from this longitudinal one to lateral margin at each spiracle. Apical tergites shaded with golden-brown on dorsum: eighth tergite completely shaded with golden-brown except for two short, yellowish, sub-mesal streaks at anterior margin, ninth tergite shaded on meson, yellowish laterally, and tenth tergite shaded at posterior margin. Occasional specimens have these color markings incomplete, but general pattern always visible. Abdominal sternites unmarked, uniformly pale yellow. Genitalia, fig. 7, tan, with delicate brown shading at margins of structures;

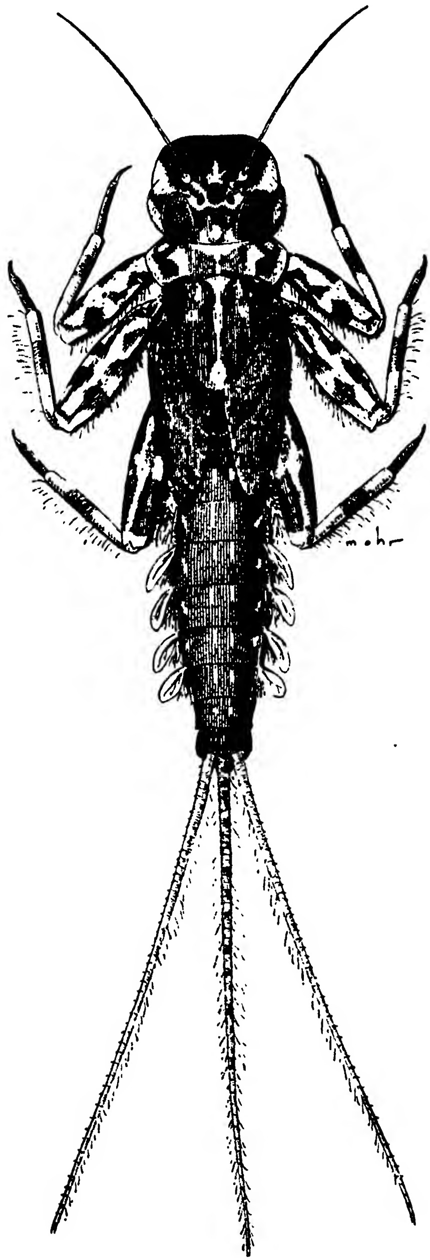


FIG. 2. *Heptagenia dial asia*, nymph, dorsal aspect.

apical margin of forceps base with a median notch; penis lobes with short median hooks and basal hooks which are stout at base. Tails white, joints brown.

Female.—Length of body 9–14 mm., of wing 10–15 mm. Ground color of body lighter than in male, almost white; thoracic notum only slightly darkened, not deeply shaded with golden brown as in male; lateral light reddish-brown thoracic streaks only faintly indicated. Black markings of head, thorax and abdomen same as in male. Apical abdominal tergites lacking dorsal golden-brown shading. Tails white, joints darkened with reddish-brown. Apex of subgenital plate, fig. 5, slightly indented on meson.

Nymph.—Length of body of mature specimens 8–15 mm. Dorsal color pattern as shown in fig. 2; dorsum of abdomen uniformly brown, with only minute dorsal and lateral light-colored markings. Abdominal sternites with a rather wide, longitudinal brown band near each lateral margin, mesal area light yellowish. Gills with dorsal plate relatively slender, subacute at apex; filamentous part conspicuous, projecting above dorsal plate, fig. 10.

Holotype, male.—Rockford, Illinois, June 29, 1938, at light, B. D. Burks. Specimen in alcohol; genitalia on microscope slide. *Allotype, female.*—Havana, Illinois, White Oak Creek, near Matanzas Lake, June 2, 1940, reared from nymph, B. D. Burks. Specimen in alcohol, with nymphal and subimaginal exuviae. *Paratypes.*—Illinois: Same data as for allotype, 4 ♂. Havana, June 1, 1933, at light, C. O. Mohr, 1 ♂. Homer, July 4, 1943, H. H. Ross, 1 ♂. Jerseyville, June 2, 1938, T. H. Frison, 1 ♂. Kankakee, Aug. 3, 1938, Burks & Boesel, 1 ♂. Kappa, June 22, 1943, H. H. Ross, 1 ♂. Mahomet, June 8, 1940, H. H. Ross, 1 ♂. Mazon, Mazon Creek, June 25–27, 1938, B. D. Burks, 3 ♂, 2 ♀, reared from nymphs. Milan, Rock River, June 4, 1940, Mohr & Burks, 5 ♂, 2 ♀, reared from nymphs. Momence, June 22, 1938, Ross & Burks, 1 ♂. Muncie, May 22, 1942, Ross & Burks, 1 ♂. Rockford, June 12, 1938, at light, Ross & Burks, 1 ♂. Iowa: Dennison, June 18, 1940, H. H. Ross, 1 ♂, 1 ♀. Red Oak, July 28, 1946, H. H. Ross, 1 ♂, 2 ♀.

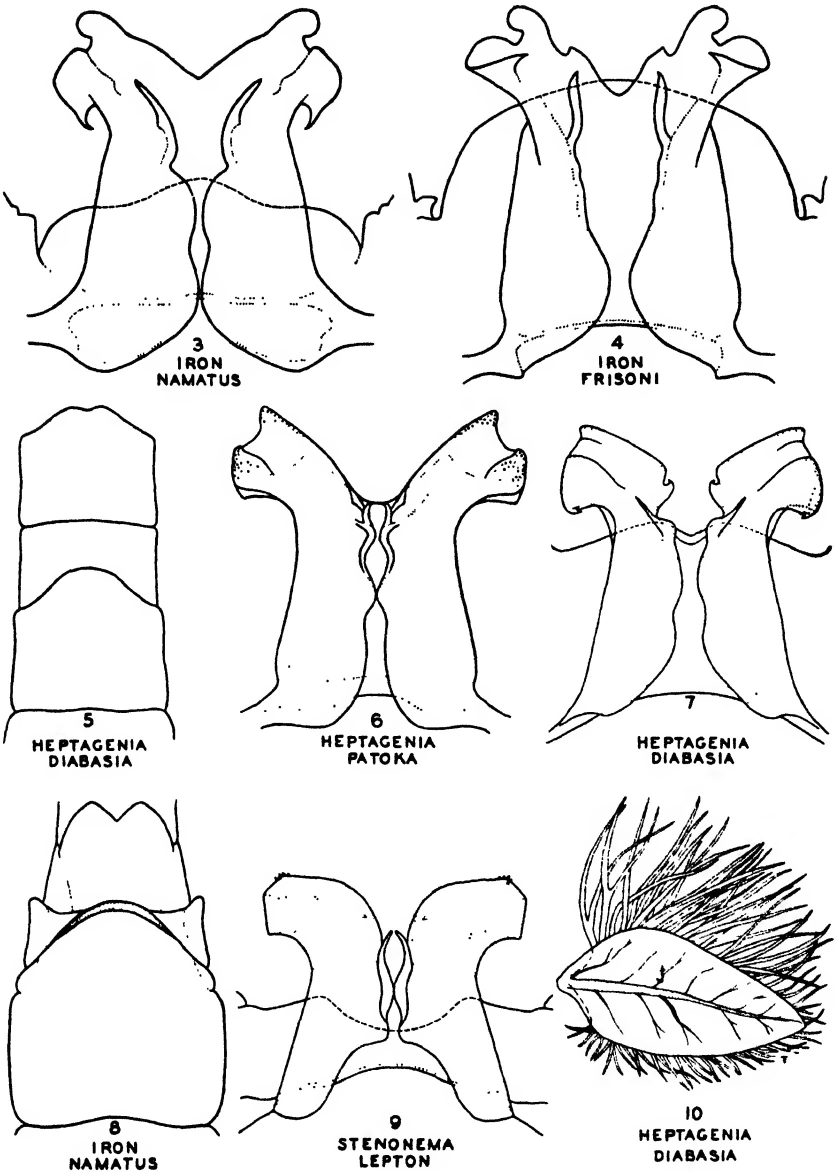
Twenty-two ♂ and 5 ♀ paratypes in alcohol; 1 ♂, 2 ♀ paratypes dry, on pins; male genitalia on microscope slide.

Nymphs.—Material, all from Illinois, was collected at the following localities: Havana, White Oak Creek, near Matanzas Lake, Nov. 5, 1939, and June 2–July 7, 1940; Mazon, Mazon Creek, June 24, 1938.

This species is most closely related to *H. elegantula* (Eaton), described from Colorado, but differs as follows: in the male genitalia of *elegantula* the median hooks of the penis lobes are long, whereas they are short in *diabasia*; also, the basal hooks are uniformly slender in *elegantula*, but are broad near the base in *diabasia*. The two also differ slightly in their color patterns, the head of *elegantula* having the pair of small black dots on the frontal shelf at compound eye margins, of *diabasia*, replaced by a pair of transverse, black stripes.

Heptagenia patoka new species

Male.—Length of body 9 mm., of wing 9 mm. General color tan, heavily marked with yellow-brown and red-brown. A member of the *flavescens* group of species.



FIGS. 3, 4. Male genitalia. FIG. 5. Female apical abdominal sternites. FIG. 9. Male genitalia. FIG. 10. Nymphal gill. FIGS. 6, 7. Male genitalia. FIG. 8. Female apical abdominal sternites.

Head uniformly tan, unmarked except for minute brown dot on meson of vertex between eyes; ocelli dark gray at bases; antennae tan, basal half of flagellum darkened, compound eyes gray shaded with tan, ventral portion darker; eyes separated on meson by a space as great as width of a lateral ocellus. Thorax brown on dorsum, shading to yellowish on pleura, apex of mesonotum and metanotum heavily shaded with brown; an oblique dark brown mark on mesopleuron ventral and anterior to wing base. Pronotum with minute dark brown mark on dorsal meson and at bases of forecoxae; foreleg light tan, a faint reddish-brown median mark and narrow subapical band on femur; tibia with a narrow brown area at apex; tarsal segments edged with brown at articulations, apical tarsal segment gray-brown; relative proportions of parts of foreleg: femur 24, tibia 28, first tarsal segment 3, second 9, third 8, fourth 5, fifth 4. Wings hyaline, light yellowish-tan in costal and subcostal interspaces of forewing; all veins and crossveins of forewing brown, anterior veins and crossveins of hindwing brown, posterior ones hyaline; crossveins in costal and subcostal interspaces of forewing broader and darker brown than others in this wing; humeral crossvein colorless at base, dark brown at Sc; small dark brown spot at bulla; stigmatic crossveins slightly slanted, not anastomosed. Abdomen brown on dorsum, light yellowish-tan on venter; tergites of first three abdominal segments with a pair of yellowish, submesal, rounded spots near anterior margin; following tergites with these spots more elongate, more vague, and considerably darkened, so as to be scarcely distinguishable from dark ground color; a faint, longitudinal, median, yellowish line present on five basal abdominal tergites. Sternites unmarked. Apical abdominal segments tan, genitalia tan, edged with brown, segments of forceps brown at articulations; tails tan, joints brown. Genitalia, fig. 6, with penis lobes relatively elongate and slender, and with median hooks short and slender.

Holotype, male.—Patoka, Illinois, July 19, 1945, Ross & Sanderson. Specimen in alcohol; genitalia on microscope slide.

This species is closely related to *flavescens* Walsh by genitalia, but differs markedly in color: in *flavescens* the abdomen is uniformly tan or brown on the dorsum, and the crossveins in the costal and subcostal interspaces of the forewing are not markedly broader and darker than the other crossveins in the wing; in *patoka* the dorsum of the abdomen is brown interrupted by conspicuous yellowish markings, and the crossveins of the costal and subcostal interspaces of the forewing are broader and darker than are the other crossveins in the wing. In genitalia the two differ in that the penis lobes of *patoka* are narrower and more elongate, with the median hooks much shorter and more slender.

Genus **Stenonema** Traver

Stenonema lepton new species

Male.—Length of body 7–9 mm., of wing 8–10 mm. General color very light yellowish, almost white, with thorax and apex of abdomen darker. A member of the *terminatum* group of species.

Head light yellowish or whitish with four small, irregular black spots at posterior margin of vertex: a small pair at compound eye margins

and a larger, submedian pair; base of antenna whitish, flagellum light tan; ocelli black at bases; compound eyes separated on meson by a space almost as wide as one compound eye. Thorax light tan, two minute brown spots on pleuron ventral to base of forewing. Pronotum unmarked; foreleg whitish, with dark red-brown band at middle and apex of femur and at apex of tibia; minute brown-shaded area at apex of each tarsal segment, claws gray-brown; relative proportions of parts of foreleg: femur 22, tibia 25, first tarsal segment 8, second 12, third 11, fourth 8, fifth 4. Wings hyaline, slightly milky in costal and subcostal interspaces, faintly red-stained and semi-opaque in stigmatic area; all crossveins in forewing brown, those in costal and subcostal interspaces slightly wider than others; veins C, Sc, and R_1 and R_2 brown, others hyaline; crossveins at bulla, in first three interspaces, arranged as 1-1-1 to 2-2-2 in all combinations: never more than two crossveins in an interspace in this area. All veins and crossveins of hindwing hyaline. Middle and hindlegs with rather faint, red-brown band in middle and at apex of femora, claws gray-brown. Abdomen whitish, a minute, dorsal black band at posterior margin of each tergite; spiracular markings wanting; sternites unmarked, apical abdominal tergites light tan, genitalia and forceps white, unmarked; tails white, joints not darkened. Penis lobes, fig. 9, angular, one pair of inner apical spines present, lateral spines wanting.

Holotype, male.—Momence, Illinois, June 22, 1938, Ross & Burks. Specimen in alcohol. *Paratypes.*—Illinois: Same data as for holotype, 5 ♂; same but June 24, 1939, Burks & Ayars, 23 ♂. Specimens in alcohol, genitalia of one male on microscope slide.

This species most closely resembles *S. terminatum* (Walsh), but has only one pair of penis spines (inner apical), rather than two pairs (inner apical and lateral) as does *terminatum*. The first segment of the foretarsus in *lepton* is two-thirds as long as the second, while in *terminatum* the first segment of the foretarsus is from one-third to slightly less than one-half as long as the second. From *bipunctatum* (McD.), *lepton* is readily separable by the color pattern of the abdominal tergites, as well as by minor differences in the male genitalia; *placitum* (Banks) has a different abdominal color pattern and slightly different male genitalia.

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PERSONAL BIBLIOGRAPHIES

The editor has received copies of two personal bibliographies in recent months.

BLISS, C. I., Connecticut Agricultural Experiment Station, Box 1106, New Haven 4, Connecticut. Fifty-three titles, chiefly on toxicology and statistical procedures, 4 pages, printed, September, 1946.

HOFFMANN, WILLIAM E., Washington, D. C. One hundred twenty-seven titles on a variety of subjects, mostly entomological and mostly on the Chinese fauna. 8 pages, mimeographed, June 30, 1944.

A DESCRIPTION OF FORMICA PARCIPAPPA, A NEW ANT FROM IDAHO[1]

(Hymenoptera: Formicidae)

A. C. COLE, JR.,
University of Tennessee,
Knoxville, Tenn.

Formica parcipappa n. sp.

Holotype, worker. (Cole collection, No. 420.)

Total length, 5.8 mm.

Head, excluding mandibles, only slightly longer than broad, broadest between upper third of compound eyes, sides slightly convex, occipital angles somewhat rounded, median portion of occipital border only slightly concave. Median lobe of clypeus moderately and broadly convex when viewed laterally, projecting anteriorly rather abruptly from its lateral portions. Clypeal impression distinct, rather deep and angular. Clypeal carina feeble. Frontal area triangular, broader than long. Frontal lobes short, subparallel, acutely pointed anteriorly. Frontal furrow faint, extending about two-thirds the distance from frontal area to median ocellus. Compound eyes oval, convex, anterior border extending slightly in front of median portion of the side of the head. Mandibles 7-toothed, stout, very convex. Antennal scapes rather stout, gradually thickened from base to apex, slightly curved, distinctly surpassing posterior corners of the head by about one-fifth their length. Funicular segments longer than broad, segments 1–4 increase in breadth from base to apex, segments 5–10 cylindrical, slightly thicker than preceding segments, ultimate segment longer than penultimate, nearly as long as the combined lengths of the two preceding segments and tapering apically.

Pronotum rather strongly convex in profile, mesonotum somewhat less so. Promesonotal suture well marked and breaks the promesonotal outline in profile. Mesoepinotal suture narrowly and not particularly deeply impressed. Epinotum higher than long, the basal face straight and the obtuse angle between it and the abrupt slightly convex declivity sharp and only slightly rounded, the two faces of about equal lengths. Thorax, seen from above, stout; pronotum with very convex sides, less than twice as wide as the dorsum of the mesonotum; behind the mesoepinotal constriction, the lower portions of the mesonotum and epinotum are parallel. Petiolar scale, when viewed from in front, with the apex not greatly broader than the base; low, wide, thick at the base anterioposteriorly; as seen in profile, the anterior face consists of a short, vertical, basal portion which passes through a distinct angle to the long, nearly straight surface sloping posteriorly to the apex of the scale; the straight posterior face is feebly convex and only slightly slopes posteriorly to the base; superior border moderately sharp, broadly

[1]Contribution No. 13, Department of Zoology and Entomology, University of Tennessee, Knoxville.

rounded and feebly notched in the middle, when viewed from in front, and the corners are rather broadly rounded. Gaster moderately large, rounded.

Head, thorax and petiole finely and rather densely shagreened, subopaque, with a faint luster. Occiput, posterior corners, sides and venter of head, and the antennae and legs somewhat shining. Frontal area faintly shagreened and very shining in certain lights. Mandibles shining, coarsely and sparsely punctate, longitudinally, finely, rather irregularly and densely striate, the striae more pronounced toward the apex. Gaster uniformly shagreened, more shining than the thorax.

Erect hairs mostly pointed, yellowish, rather abundant, varying in length; most numerous on the gaster where they are scattered and longer on the posterior portion and the venter; on the head most abundant on clypeus, shorter on vertex, very sparse but long on gula, very short and sparse on occiput; a cluster of 20 long and shorter hairs on dorsal convexity of pronotum, eight much shorter ones on anterior portion of dorsum of mesonotum (just anterior to the mesoepinotal suture), a group of six moderately long ones on epinotum at posterior portion of epinotal base (near the angle of the epinotum), prominent along superior border of petiolar scale (and extending around the corners); long on coxae, shorter and less numerous on femora of fore legs and flexor surfaces of middle and hind femora. Pubescence fine, indistinct, rather short and everywhere sparse; most prevalent on antennae, anterior surface of petiolar scale and on the gaster (where it is somewhat longer and denser but does not obscure the shagreened surface.)

Light ferruginous, head slightly darker, antennae somewhat darker than the head, mandibles rich reddish brown, superior border of petiolar scale dark reddish brown. Posterior borders of first three gastric segments each with a broad, somewhat irregular transverse light brown band which is darker than the rest of the gastric segment and which narrows laterally and widens greatly ventrally; median portion of first gastric segment slightly suffused with brown.

Variation in Paratype Series.—Total body length varies from 4.9 to 5.8 mm. In some specimens the frontal area is nearly equiangular, and in none is it longer than broad. In the smaller workers the color of the body is somewhat darker, and there are distinct splotches of brown on various parts of the head (notably the vertex and genae) and the pronotum and mesonotum; in a few of the paratypes the increase in breadth of antennal funicular segments includes segments 5 and 6, although decreasingly so; in some specimens the petiolar scale, when viewed from in front, has more diverging sides than that of the holotype (and hence is proportionately broader at the apex than at the base), the superior border is less broadly rounded and its corners are more sharp; the thoracic hairs are more delicate; the occipital border is straight and the sides of the head are more convex. In some specimens, irrespective of their size, the clypeal notch is deeper and more distinct than in others; in no specimen is it indistinct. The length of the frontal furrow varies greatly, but on the average it does not extend more than one-half the distance from the frontal area to the median ocellus. Two specimens lack hairs on the gula, the others possess one or two rather long gular

hairs; two specimens have only one or two distinct occipital hairs; one specimen bears a few short hairs on the occiput, the posterior corners of the head, the genae and the sides of the head behind the eyes. One large worker has the genae, thorax, petiolar scale and gaster flecked with brown. The gaster of one of the paratypes is not at all banded with brown, and the gaster of a few others is only very slightly banded. In one worker of medium size, the gaster is more densely pubescent.

Type Locality.—Near Nampa, Idaho. The holotype and the fifteen paratype workers were collected by the writer, July 11, 1931. The workers were foraging on the ground in a community of greasewood and shadscale. The nest was not found. The slave is unknown.

Affinities.—The clypeal notch identifies this species as a member of the Sanguinea Group. At the first appearance of *paricipappa*, one is reminded of *bradleyi*, because of the similarity in coloration. The two species have little in common, however. The new species is of considerably greater size, the head has a different shape, the clypeal carina is much more feeble, the clypeal notch is very much deeper and less broad, the petiolar scale is broader and has a sharper superior border, the epinotum is more angular, the pilosity is much less abundant and less evenly distributed, and the body is less shining.

The new species appears to be most closely related to *wheeleri*, which it resembles structurally rather closely, but from which it differs by such characters as follows: the shape of the head is somewhat different; the basal and declivous faces of the epinotum are of about equal length, and the angle formed by the two surfaces is much sharper and less broadly rounded in profile; the pronotum is more convex; the promesonotal impression breaks the promesonotal outline; the petiolar scale is proportionately somewhat broader at the base, and the corners of the superior border are more rounded; the genae lack coarse and shallow punctures; the lobe of the clypeus lacks striae; the pubescence is more dilute; the body surface has more of a luster; and the color is different.

The writer is indebted to Dr. W. S. Creighton, who kindly compared specimens of the new species with types of *emeryi* and *pergandei*. Paratypes are to be deposited in the U. S. National Museum and in the collection of the writer.

THE TABANIDAE OR HORSEFLIES AND DEERFLIES OF GEORGIA, by P. W. FATTIG. Emory University Museum Bulletin, No. 4, pp. 25, 1946.

This pamphlet is a companion to Dr. Fattig's Asilidae of Georgia, reviewed last year, and follows the same plan of treatment. The first few pages are devoted to acknowledgments and brief statements on economic importance and life history. A page is occupied by some notes on parasites and predators which attack these flies. The author's comments on collecting tabanids are interesting. The major part of the bulletin includes a list of one hundred and eighteen species with data on distribution but no other material. A bibliography of thirty-four titles concludes the work.—A. W. L.

LARVAL DETERMINATION OF SIX ECONOMIC SPECIES OF LIMONIUS
(Coleoptera: Elateridae)[1]

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Wireworms are primary insect pests of crops in the irrigated lands of the Pacific Northwest, and more locally throughout the United States. Those of importance to agriculture throughout this country represent perhaps three-score species, distributed among several genera. In the Pacific Northwest the most important species belong to the genus *Limonius*, and the major part of the control work has been done on these species. The Pacific Coast wireworm (*Limonius canus* Lec.) and the sugar-beet wireworm (*L. californicus* Mann.) are generally distributed throughout both the irrigated and the naturally moist areas of the semiarid portions of the United States west of the Rocky Mountains. The western field wireworm (*L. infuscatus* Mots.) and the Columbia Basin wireworm (*L. subauratus* Lec.) are not so generally distributed, but are of economic importance in limited areas, and are frequently associated with *L. canus* and *L. californicus*. Observations, field studies, and laboratory experiments show that the larvae and the adults of these species show specific differences in their response to field conditions and treatments.

In the Eastern United States[2] the eastern field wireworm (*L. agonus* (Say)) and *L.* (*Nothodes*) *dubitans* Lec. are of economic importance in certain areas and under certain conditions. Two other species that are probably of economic importance are *L. ectypus* (Say) and *L. anceps* Lec.

The close relationship of the four eastern species to the four western species, as shown by the adults and by the larval stages so far as they are known, make it probable that their activities and responses in the field are similar. In this study on larval determination it seems advisable to include *agonus* and *dubitans* with the four western species. Accurately determined larvae of *ectypus* and *anceps* are not available for study. This group of closely related species is part of what might be considered a subgenus.

For several reasons larval determination is more important in the study of wireworms in general, or of any group of wireworms in particular, than it is in the case of most insects. The life cycle in most species ranges from 2 to 6 or more years. The flight activity of the beetle makes it impossible to determine either the field from which it first emerged or that in which it may have oviposited. Moreover, the

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[1]This work was done at Walla Walla, Washington, as a part of wireworm investigations conducted in the Pacific Northwest under the direction of Merton C. Lane.

[2]In this paper Eastern United States refers to the region east of the 105th meridian, Western United States to the region west of this point.

beetle stage does not exist during part of the season. Any change in species dominance due to change in farm practice is not indicated by adult populations for approximately 3 years. The months, and usually years, required to rear to adults an adequate sample of the wireworms

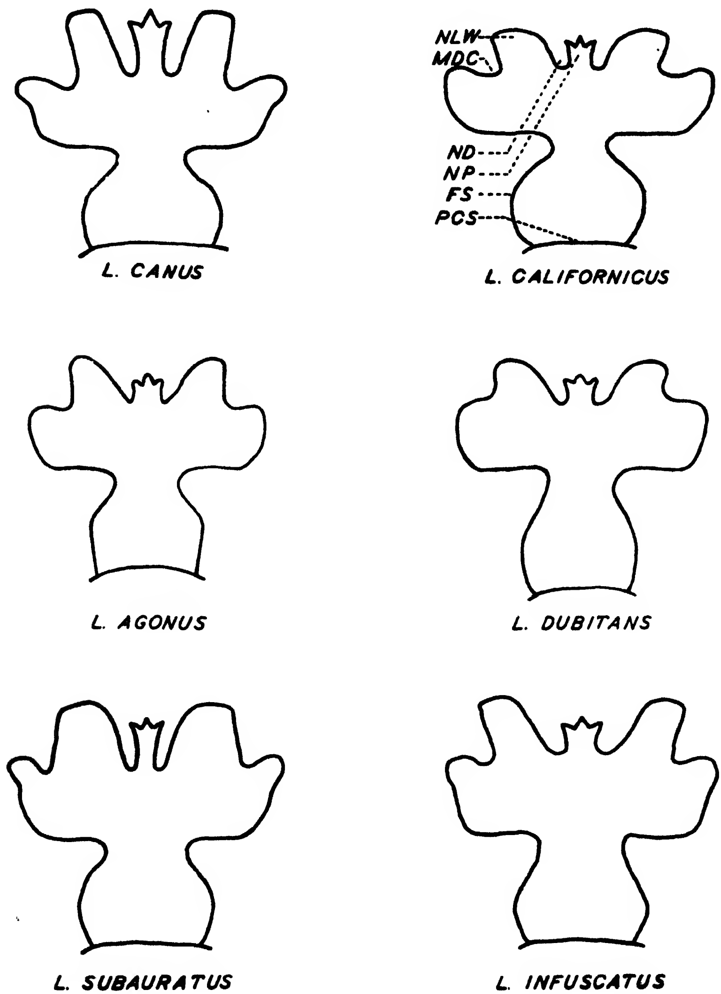

FIG. 1. Portion of dorsal surface of head capsule: *FS*, frontal suture; *PCS*, post-occipital suture; *MDC*, dorsal condyle of mandible; *NP*, nasal projection; *NLW*, lateral wings of nasals; *ND*, nasal depression.

used in an experiment, or found in a field, makes rearing impractical even if the process itself frequently does not provide difficulties. This long period of larval development, together with the fact that all the

immature stages and most of the adult life are spent in the soil, makes essential a means of recognizing the species in the larval stage.

The recognition of this need for the classification of elaterid larvae is not new. Until recently most of the work on these larvae has been done in Europe on species of *Agriotes*. Most of the early investigators dealt with field-collected larvae, and their results contain several serious errors in determination. Few of the pioneer workers were acquainted with the changes that occur to the individual larvae, especially those due

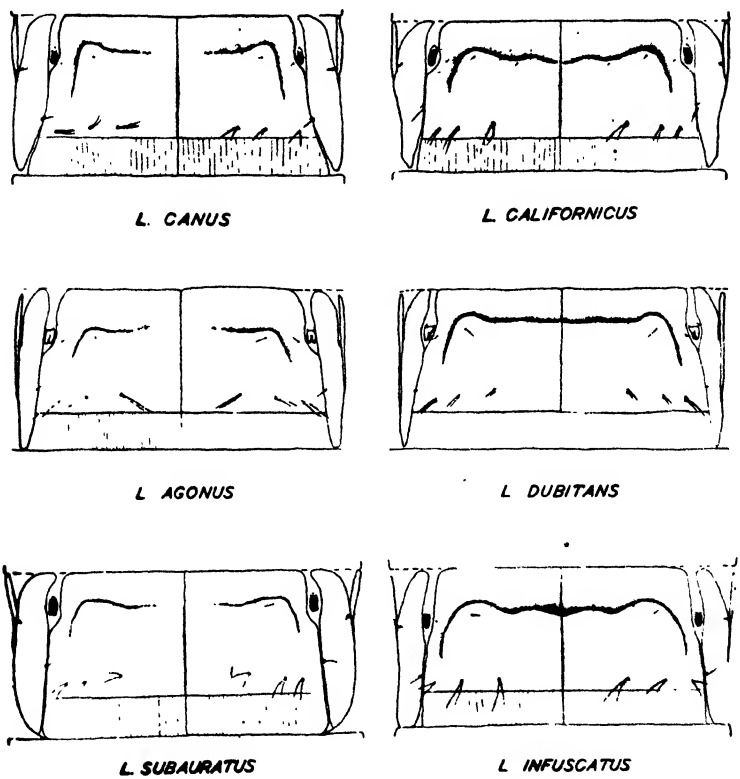

FIG. 2. Dorsal surface of third abdominal segment.

to wear during the period between molts. The size, form, and length of the mandibles and the nasal projection were therefore used as primary characters by such outstanding authorities as Schiodte (6) and Henriksen (3). Horst (4) recognized that the nasale was subject to extreme wear, but did not mention that the mandibles may lose much of their length and all the acuteness of their tips as a result of wear during the period between molts. Furthermore, Horst did not call attention to the complete renewal of both nasal projection and mandible, which is normal in each instar, but wrote rather confusingly of the worn condition of these structures in the older stages of the larvae.

The following descriptions and key to the larvae of six species of *Limonius* should provide a means for separating these larvae. The notes and illustrations included in this paper are only those parts of the morphological studies which are expected to be of direct assistance in the understanding of the key. The terminology is that used by the author (5) in a detailed description of the external anatomy of the larva of *canus*. The resulting determination of species should make possible greater accuracy both in experiments and in recommendations for control.

DESCRIPTION OF LARVA

Limonius larvae are to be recognized among elaterid larvae by the largely sclerotized body covering, with visible membranous areas in the pleural regions; by the ninth abdominal segment with a pair of well-separated terminal urogomphi, the horizontal branches of which bend mesally to enclose a cavity, or keyhole, but without other armature such as horns on the tergal plate or scansorial hooks on the surface of the anal projection; and by the subquadrangular postlabium which separates the stipites throughout their length. The mandibles of these larvae each have a proximal tooth or lobe as well as a distal one. The nasal projection has three distinct and nearly equal teeth, and the urogomphi have distinct vertical branches. There is no evidence of eyespots or ocelli.

Head Capsule.—In general form the head capsule of the various species is similar throughout. The frontal sutures (FS) (fig. 1) are the most apparent features of the dorsal surface. These arise, somewhat separated, from the postoccipital suture (PCS) or base of the head capsule, diverge anteriorly to approach again near the center of the dorsal surface of the head, and then suddenly separate to pass around the dorsal condyles of the mandibles (MDC), and close by the bases of the antennae. Measurements taken at points on these sutures illustrate that the head capsule of the larva of *californicus* is both broader and blunter than in the other species. Thus in this species the distance between the sutures at the point of medial constriction is only one-fifth of that between the anterior ends outside the mandibular condyles; in the other species it is one-fourth. In *californicus* the distance from the base of the nasal projection (*NP*) to the median constriction is only two-thirds of that from the constriction to the bases of the frontal sutures on the postoccipital suture, and in the other western species the two lengths are equal. In the two eastern species the first distance is slightly less than the second.

Tergites of First Eight Abdominal Segments.—The tergites, or dorsal sclerites, of the first eight abdominal segments are mainly characterized by the anterolateral, or anteromarginal, grooves. These grooves, which parallel much of the anterior and lateral margins of each of these tergites, appear to be superficial sculpturings on the terga. They are, however, uniform in length and in intensity within the species, and are developed to their greatest extent on the terga of the second, third (fig. 2), and fourth abdominal segments. In *infuscatus* larvae the groove is strongly marked by the heavy sclerotization on its anterior and lateral margins. The grooves usually extend to the median suture and join without any

evidence of a break. Occasionally they end short of the median suture, but always near it and very abruptly. In *californicus* and *dubitans* the demarcation of the groove is strong. The termination of the anterior portion of the groove is at or near the median suture and is very abrupt. In these two species, however, the grooves are seldom connected across

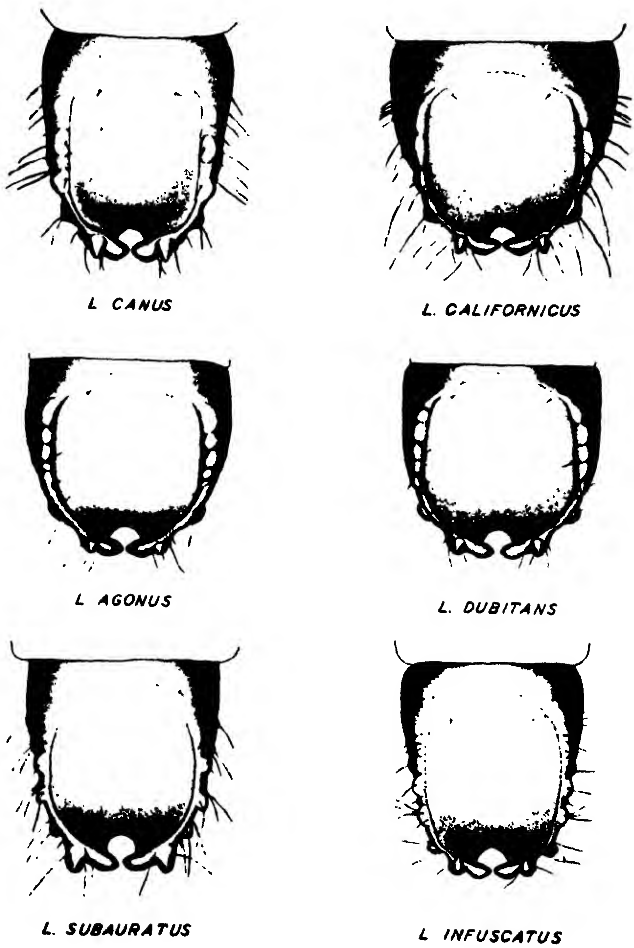

FIG. 3. Dorsal surface of ninth abdominal segment.

the median suture. In *canus* and *agonus* the anterior and lateral margins of the grooves are less strong and the anterior portion of the groove gradually fades out mesally, ending, sometimes after one or more breaks, a short distance from the median suture. In *subauratus* the condition is similar to that of *canus* but even less distinctly marked,

and the anterior portion of the groove fades out some distance from the median suture.

Hawkins (2, p. 64) illustrates and briefly described a *Limonius* larva, but overstresses the size of the setae of the anterior portion of the abdominal segment, and fails to realize the value of the anterolateral grooves in this group.

The Ninth Tergite.—In each of these larvae the dorsal plate of the ninth abdominal segment (fig. 3) is more highly specialized than are the similar plates of the preceding segments. The anterolateral groove

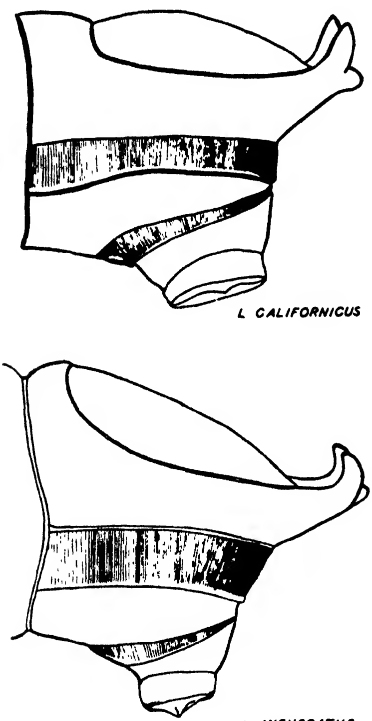

FIG. 4. Lateral view of ninth and tenth abdominal segments.

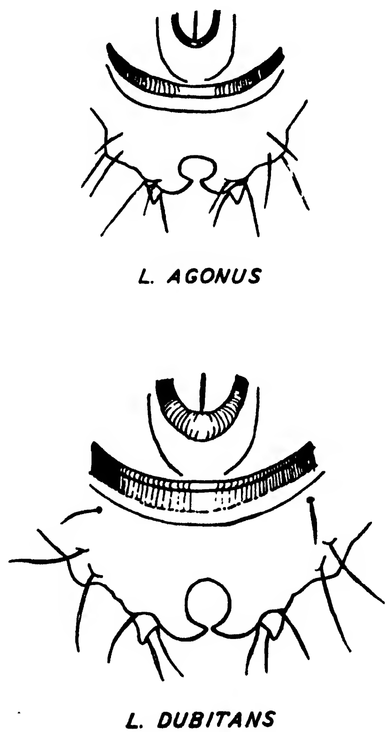

FIG. 5. Ventral view of keyhole of last abdominal segment.

outlines a large, nearly smooth tergal plate which is gradually elevated to the middle, but without the median suture. The lateral margins of the grooves become more elevated and rugose as they extend posteriorly and terminate in paired urogomphi, each of which is branched. The tergal plate is rounded anteriorly, nearly straight laterally, and posteriorly depressed and extending between the urogomphi to the keyhole opening. In *canus* and *infuscatus* the plate is longer than wide, in *californicus* and *subauratus* wider than long, and in *agonus* and *dubitans* approximately as wide as long. The gradually increasing height of the

lateral elevations and of the urogomphal structure makes the plate appear to be longer than it is and to narrow distally more than it does. In *subauratus* the tergal plate is more rounded and, like *infuscatus*, is flatter than the other species; even the eastern species have more angulate corners.

The elevations, or warts, on the lateral margins of *canus* and *californicus* are elongate, beadlike oval masses. On *infuscatus* these warts are more concave on the inner surface and tend slightly toward the almost earlike scallops found on the margins of the tergal plate in certain other genera, for example, *Drasterius* and *Hypnoidus*. These concavities are for the reception of single spines. In *subauratus* this condition is somewhat intermediate between *canus* and *infuscatus* but approaches *infuscatus*. *Limonius agonus* and *L. dubitans* closely resemble *canus* in this respect, with the lateral margin perhaps less elevated and less rugose. In *californicus* and *infuscatus* these warts are more rugged, and usually more numerous, than in the other associated species.

The parts of the paired urogomphi may be termed the "vertical" and the "horizontal" branches. The vertical branch of each urogomphus is the smaller of the two branches, and may appear as little more than a conelike enlargement of the warts in the lateral margin of the tergal plate. Although in most of these species the vertical branches arise nearly perpendicular to the plane of the larval body, in *infuscatus* the original direction is slightly posterior and as it arises the branch is gradually bent anteriorly. The result is a uniformly bent, anteriorly directed sharp hook (fig. 4). The vertical branches in the other species are tapered and erect, although the slant is likely to be steeper on the anterior and mesal faces, as in *californicus* (fig. 4). In *subauratus* certain specimens may have this steepness so pronounced as to give a first impression of being slightly hooked. The distance between the tips of the vertical branches is of taxonomic value. In *canus*, *infuscatus*, and *agonus* this distance is approximately twice the length of the transverse axis of the keyhole. In *californicus* and *subauratus* the distance is about three times this measurement of the keyhole, and in *dubitans* the condition appears to be intermediate, the distance between the tips being approximately two and one-half times the length of the transverse axis of the keyhole.

KEY TO THE LARVAE OF SIX ECONOMIC SPECIES OF LIMONIUS

1. Inner ends of anterolateral grooves of second, third, and fourth abdominal tergites remain strong as they approach the median suture.............. 2
   Inner ends of anterolateral grooves of second, third, and fourth abdominal tergites fade and end before reaching the median suture................ 4
2. Vertical urogomphi curved anteriorly to form hooks; ninth tergal plate flattened, its elevated lateral margin with concave scallops, its anterior angles rounded. Western United States.......................**infuscatus**
   Vertical urogomphi not recurved to form hooks; ninth tergal plate convex, its elevated lateral margins with wartlike swellings, its anterior angles angulate.. 3
3. Distance between ends of frontal sutures outside of mandibular condyles five times that between these sutures at point of medial constriction. Western United States....................................**californicus**
   Distance between ends of frontal sutures outside of mandibular condyles four times that between these sutures at point of medial constriction. Eastern United States....................................**dubitans**

4. Width of urogomphal keyhole approximately one-half distance between tips of vertical branches of urogomphi; ninth tergal plate convex, its elevated lateral margins with beadlike swellings, its anterior angles angulate........ 5
   Width of urogomphal keyhole approximately one-third distance between tips of vertical branches of urogomphi; ninth tergal plate flattened, its elevated lateral margins with concave scallops, its anterior angles rounded. Western United States.......................................**subauratus**
5. Ninth tergal plate rounded, only slightly angulate. Eastern United States..**agonus**
   Ninth tergal plate elongate, distinctly angulate. Western United States, **canus**

The larvae of *infuscatus* are readily distinguished from those of the other species, as they have the tips of the vertical urogomphi curved anteriorly to form hooks (fig. 4). The larvae of *canus*, *dubitans*, and *agonus* are recognized by the direction of the origomphal keyhole. In these species it forms an angle of about 45° with the plane of the body, pointing posteriorly as much as downward. In the other species the angle formed is nearly 90° or almost vertical. The larvae of *californicus* are unique in that the distance between the frontal sutures where they are bent inward is only one-fifth that between the bases of the antennae, as compared with a distance of one-fourth (fig. 1) in the other species. The larvae of *subauratus* are separated from those of *infuscatus* by the more nearly circular tergal plate, circular keyhole, and straight tips of the vertical branches of the urogomphi, as well as by the briefer, fainter inner ends of the anterolateral grooves. The two eastern species are also readily distinguished by the shape of the keyhole as viewed from beneath (fig. 5). In *dubitans* it is circular and in *agonus* irregularly ovoid.

Glen *et al.* (1) divide the *Limonius* larvae into two groups. All six of the species included in this study belong in their group 2 and would be under caption 33 of their key.

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A REVISION OF THE GENUS LACHESILLA NORTH OF MEXICO[1]
(Corrodentia: Caeciliidae)

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The family Caeciliidae (according to Chapman's classification, but with the addition of more recent records) contains at least thirty-nine previously described Nearctic species. The genus *Lachesilla* is one of nine genera in the family Caeciliidae and contains ten previously described species for this region. This study treats twenty-four species, twelve that are new to science, one that is here transferred to this genus, one that was previously considered a variety and is here elevated to species rank, and the ten species previously placed in *Lachesilla*.

In so far as I have been able to determine eleven species in this genus have been described from Europe, Mexico, Central and South America. Very likely many more species occur in this genus, some of which have already been described under *Caecilius* or closely related genera, besides others yet to be described. Corrodentia as a whole have not been intensively collected throughout this country. Judging from the material examined, .the Lachesillas have been neglected too. Most of the more intensive collecting has been done around Ithaca, New York; Urbana, Illinois, and Mt. Carmel, Connecticut.

In general the species of *Lachesilla* are found out-of-doors breeding in dried leaves hanging in bunches on trees, dried grass in the fields, dried cornstalks, on branches and twigs of conifers and in ground-cover. The individuals are usually found on the inside of the curled, dried leaves or in other protected situations. Some species breed indoors under favorable conditions in mouldy organic materials such as: cereals, straw, papers and wood.

Not much is known concerning the bionomics of the species in this genus, but the few I have reared or observed, namely: *nubilis*, *pedicularia* and *contraforcepeta*, deposit their eggs singly and do not cover them with conspicuous silk mats. The eggs are oblong-oval, especially after development is well under way, with a spoon-shaped groove on top, fig. 46. One species at least, *contraforcepeta*, deposits flat, oval eggs that thicken as development proceeds. From information based on *pedicularia* and *nubilis* the egg stage lasts about one week, the six nymphal stadia cover a period of two or three weeks, and the adults live about two weeks. Figs. 46, 48, 47, and 49 are egg, fifth instar nymph, adult female and a male of *Lachesilla nubilis* (Aaron) respectively, a widely distributed species typical of the genus. In this region the species apparently overwinter mainly in the egg stage. It is interesting

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to note that the fall eggs of *contraforcepeta*, unlike the other two species, do not hatch until subjected to a period of cold. Males are known for all but three of the twenty-four species concerned in this paper. Although it is possible, it should not be inferred that these three species are parthenogenetic because few collections of these three species are at hand, and the males have probably not yet been taken. The silk produced by the nymphs and adults is inconspicuous. The nymphs and adults feed on fungus growths and organic material. In this region they are most abundant in the late spring and fall of the year.

ACKNOWLEDGMENTS

I wish to thank Professor C. L. Metcalf of the Department of Entomology, University of Illinois, for his helpful criticisms and suggestions and for his kindness in supplying necessary equipment for this study.

I am greatly indebted to Dr. H. H. Ross of the Illinois Natural History Survey for his active interest in this project and for his many helpful suggestions throughout the entire course of this study.

Dr. P. J. Chapman of the New York Agricultural Experiment Station kindly put his collection at my disposal for study. His previous studies of the Isotecnomera and those of Dr. A. B. Gurney of the United States National Museum greatly simplified this one, for which I am, indeed, very grateful.

Dr. G. F. Knowlton of the Utah State Agricultural College, Dr. V. E. Shelford of the University of Illinois, Garland T. Riegel of the Department of Entomology, University of Illinois, Harry Hoogstraal of the Chicago Natural History Museum, Mrs. G. V. Sommerman of Mt. Carmel, Connecticut, and Dr. P. J. Chapman collected and contributed as gifts, material in excellent condition, which furnished valuable distribution data. The following people likewise collected Corrodentia in order to further this project and lent them for study: the late Dr. T. H. Frison, Dr. H. H. Ross, and Dr. M. W. Sanderson of the Illinois Natural History Survey; Dr. R. H. Beamer of the University of Kansas; Mrs. J. A. Ross of Urbana, Illinois; Dr. G. J. Spencer of the University of British Columbia; Charles A. Fleschner of the University of California at Berkeley and R. R. Dreisbach of Midland, Michigan. I would like to take this opportunity to express my appreciation of the generosity and co-operation of the above-mentioned individuals.

The following institutions loaned for study their material in the genus *Lachesilla:* Illinois Natural History Survey, United States National Museum, Pennsylvania State College, North Carolina State College, Massachusetts State College, Ohio State University, University of Kentucky, Cornell University, Chicago Natural History Museum, Michigan State College, University of Minnesota, Dominion Entomological Laboratory at Saskatoon, University of Kansas, Kansas State College, South Dakota State College, North Dakota State College, State College of Washington, University of British Columbia and University of California at Berkeley. I wish to thank the Curators, or those in charge of the collections, at these institutions for the use of their material, for without it this study could not have been made.

COLLECTION, PRESERVATION, PREPARATION

The equipment used in collecting is all relatively simple and is easily obtained. The necessary articles are: sweeping net, aspirator, pipette, forceps, sifter and white cloth, vials and 80% Ethyl alcohol.

After beating or sweeping conifers, dried vegetation, shaking bunches of dried leaves in the net, etc., one can gradually open the net and pick up the psocids with an aspirator, because they are rather sluggish and do not fly readily. When sifting ground-cover a cloth bag with a quarter-inch wire mesh bottom works well. Several handfuls of ground-cover, such as dead leaves, twigs, dry grass, etc., are put into the sifter and shaken several times over a white cloth. The psocids can be picked up quickly from the sheet with an aspirator. Sometimes curled, dried leaves or corn sheaths opened by hand reveal whole groups of *Lachesilla* adults, nymphs and eggs. If the vial type of aspirator is used the psocids can be killed, after shaking them to the bottom, by quickly pouring in one or two cc. of alcohol. Then the specimens can be transferred to a vial by pouring, by means of a pipette, or the larger ones can be handled with forceps. A penciled field label should be dropped into the vial.

Material of *Lachesilla* as with other Corrodentia in general, is best preserved in 80% Ethyl alcohol. Homeopathic rubber-stoppered vials are most satisfactory for storage because there is very little evaporation over a long period of time, and the vials, if kept in racks, are easily manipulated. It is best to put the specimens in a small shell vial 25–35 mm. long and plug the opening with cotton while it is submerged in the Homeopathic vial of alcohol thus eliminating the possibility of an air bubble in the shell vial. Then the shell vial with its contents is removed, inverted, and dropped back into the lip vial, cotton-end down. The collection data, including locality, date, habitat or host, and collector are printed in ink (Higgins Eternal Black) on a small label and put in the lip vial along with the identification label, both with printed side out. This little inner tube, or shell vial as it has been called, prevents the psocids from becoming battered or chopped up by the movement of the labels in the alcohol. It is well worth the added time and expense.

Pinned specimens or pointed material are very unsatisfactory and have to be removed from the pin, cleared and studied in alcohol. In some cases of borrowed pinned material, the whole specimen was soaked from the pin or point and prepared for study. After determination it was put in a tiny 10x4 mm. vial with a little glycerin in the bottom. Care should be taken to make sure that the KOH is entirely removed from the specimen and that the opening of the vial is dry. This prevents the cork from turning black and disintegrating. Then a pin was put through the cork and the whole treated as a pinned specimen.

Slide mounts *in toto* are still more *unsatisfactory* because they require more time to prepare and then the specimen can not be manipulated and the necessary characters can not be seen.

The abdomen is cut off under the microscope with a small scalpel or razor chip. I have found a scratch-pen very useful for this purpose. It

is then left in 2–5% KOH for 8–12 hours (usually over night) at room temperature. Then it is removed and placed in distilled water and the contents squeezed out. One can eliminate this squeezing process if the abdomen is cut off about one-third of the way from the thorax for then the contents do not rupture the abdomen upon swelling when placed in distilled water. The terminalia can be studied in this condition and many of the species determined without staining, if one is careful to manipulate the light. In staining I have submerged the abdomen in a drop of Mercurochrome on a slide and left it for several minutes. Then if it is removed and rinsed a bit in 70% alcohol the opaque red disappears and leaves a delicate pink specimen. This can be studied in alcohol in a Syracuse dish, and held in place by means of a small gob of Petroleum jelly on the bottom of the dish. The specimen can be cleaned of grease by rinsing in Carbon Tetrachloride and transferring to alcohol. Sometimes it is necessary to put the specimen in a "Well" slide in glycerin and study it under the high power of a regular compound microscope. In most cases I have returned the terminalia or terminalia parts to alcohol and put them in 10x4 mm. vials, placed in the Homeopathic vials, but outside the inner tube.

DISPOSITION OF TYPE MATERIAL

Holotypes, allotypes and paratypes have been deposited in the collections of the following individuals or institutions: Chicago Natural History Museum (CNHM), Canadian National Museum (CNM), Cornell University (CU), Dominion Entomological Laboratory at Saskatoon (DELSS), Illinois Natural History Survey (INHS), Kathryn M. Sommerman (KMS), University of Kansas (KU), Museum of Comparative Zoology at Harvard University (MCZ), Philadelphia Academy of Natural Sciences (PANS), Paul J. Chapman (PJC), University of California at Berkeley (UCB) and the United States National Museum (USNM). The institutions are referred to by the above abbreviations, which in the text, follow the locality records.

CLASSIFICATION

Genus **Lachesilla** Westwood

Lachesilla Westwood (1840, p. 47). Genotype, monobasic; *Termes fatidicum* L. (See Gurney, 1939.)

Terracaecilius Chapman (1930, p. 343). Genotype by original designation: *T. pallidus* Chap. New Synonymy.

This genus includes small apterous to macropterous psocids with 13-segmented antennae and 2-segmented tarsi. The wings are in most species well developed with Cu_{1a} and Cu_{1b} present in the forewings and Cu_{1a} not joined to M. There are no conspicuous hairs present on the wing margin, veins or in the cells (fig. 45). Chapman (1930) includes keys to the families and genera of the Isotecnomera accompanied by general discussions for each category, therefore such information is not repeated here.

Until Chapman's paper appeared the majority of the descriptions of psocids from this country dealt mainly with the gross or superficial

characters such as general color, color-pattern, size and wing venation. As specific characters these are relatively consistent, but often the degree of difference between species is so slight that positive determination can not be made when using these characters alone. In reference to characters of wing venation there is one species possessing subapterous forms, others with brachypterous or subapterous females and macropterous males; so it is evident that difficulties would be encountered in these particular cases. Also, there are often anomalies in wing venation and when such peculiarities occur on both wings of a specimen characters of venation are misleading. When color is used there is always the difficulty of determining newly emerged adults that have not yet obtained their normal coloration. Characters of wing venation are usually not specific characters, but are of generic value.

In this genus excellent morphological characters of specific value are to be found in the terminalia of both sexes. Some comprehensive studies have been published on the morphology of the Corrodentia (Badonnel 1934, Cope 1940) but the conclusions reached by the various workers do not entirely agree. This is probably because of the fact that each has limited his study to one particular species. I am of the opinion that a morphological study of several members of each genus in the order would result in definite and well-founded conclusions as to the homologies of the various structures. Therefore I believe it is not wise at this stage to coin new terms for specific parts or to try to apply to certain structures any more of the accepted specific terms used in other groups of insects. To avoid unnecessary change I have therefore followed Chapman's terminology which is very general and I have used labeled illustrations to indicate the actual structures referred to. The abbreviations used on the plates are given in parentheses after each term in the following list.

STRUCTURES COMMON TO BOTH SEXES

Sense tubercles (ST).—The conspicuous lateral or lateroventral tubercles posteriorly on the terminalia. The tubercles are covered with setae, each of which is inserted in a circle of membrane. These tubercles are present in all species and are very conspicuous in all excepting *pallida* females; therefore they are here used for purposes of orientation.

Paraprocts.—The lobes bearing the sense tubercles, laterad of the anus.

Suranal plate (SAP).—The terminal dorsal lobe posterior of the sense tubercles.

STRUCTURES OF MALES

Prongs of paraprocts (PR).—Sclerotized prongs, when present, on the ventral, mesal, usually distal region of the paraprocts.

Parameres (PAR).—The ventral, long slender, paired, mesal structures, internal, at least basally, and usually fused at the base to form a Y-shaped structure.

Claspers (CL).—The long paired, ventral, external structures anterior and mesad of the sense tubercles.

Hypandrium (HYP).—The pigmented region lying ventrally between the sclerites bearing the claspers.

Groove clasp (GC).—Sclerites overlapping the claspers about midway in *punctata.*

Lateral hooks (LH).—Lateral projections of the suranal plate.

STRUCTURES OF FEMALES

Gonopophyses (GON).—The ventral, paired, flat, external, thumb-like projections antero-mesad of the sense tubercles.

Subgenital plate (SGP).—The broad external, ventral plate anterior of the exterior genital opening.

Ventral interior plate (VIP).—The sclerotized and sometimes pigmented internal plate which forms the ventral surface of the egg passage. In several species this plate has apparently become fused externally to the posterior margin of the subgenital plate.

Dorsal interior plate (DIP).—The sclerotized and sometimes pigmented, internal (for the most part) plate which forms the dorsal surface of the egg passage, and lies mesad between the bases of the gonapophyses.

Lateral projections (LP).—When present, the distal, lateral projections of the subgenital plate.

Flap (F).—The external, median distal process of the subgenital plate, present in some species.

KEY TO SPECIES

Terminalia ventrally possessing long, slender, mesal structures, internal, at least basally (parameres), figs. 1–18, 41–43 .... **males**

Terminalia ventrally possessing plate-like mesal structures, if long and slender, then external, figs. 19–40, 44 .... **females**

MALES

1. Parameres fused basally, forming a single median shaft 2
   Parameres independent, or at least not forming a single median shaft 18
2. Paraprocts bearing sclerotized prongs mesally 3
   Paraprocts fleshy and lobe-like mesally, no prongs 13
3. Distal margin of suranal plate bilobed, fig. 12; or produced into two lateral processes, figs. 6, 14, 16, 18, 41; or bilobed with two small median hooks, almost completely fused, fig. 5 4
   Distal margin of suranal plate not lobed but evenly rounded, fig. 13; or produced into a single median process, figs. 9, 15, 17 10
4. Lateral hooks of suranal plate twisted, asymmetrical; claspers fused to form a single median asymmetrical process, fig. 6 .... **silvicola**
   Terminalia symmetrical 5
5. Two pairs of long slender, external processes (claspers), with bases side by side, present ventrally, figs. 5, 12 6
   Only one pair of long slender, external processes (claspers) present 7
6. Central shaft of parameres one and one-half times length of longer laterad clasper-like process, fig. 5 .... **riegeli**
   Central shaft of parameres about one-half length of laterad clasper-like process, fig. 12 .... **corona**
7. Prongs of paraprocts strongly sclerotized and flared distally; suranal plate produced into two knobs (dorsal and ventral) laterally, fig. 16 .... **dona**
   Prongs of paraprocts short, not modified; suranal plate with single lateral lobes, figs. 14, 18, 41 8
8. Hypandrium produced posteriorly into acute median projection; prongs of paraprocts projecting mesally, fig. 41 .... **penta**
   Hypandrium transverse or small and rounded posteriorly; prongs of paraprocts directed posteriorly, figs. 14, 18 9
9. Claspers long, double-curved, flat blades; their length about three times the distance between their bases; parameres protrude externally about half way µp length of claspers, fig. 18 .... **nubilis**
   Claspers simple, curved; their length about two-thirds the distance between their bases; parameres internal, sometimes extreme tips protrude slightly, fig. 14 .... **arnae**
10. Suranal plate evenly rounded; claspers sickle-shaped, turning laterally; non-fused portion of parameres long, delicate, posteriorly-directed blades, fig. 13 .... **rufa**

Suranal plate with median process; claspers directed posteriorly or mesally; non-fused portion of parameres complex or directed laterally, figs. 9, 15, 17 11

11. Median process of suranal plate long and slender, extending dorso-anteriorly to membranous abdominal segments; claspers fixed, fig. 9 .... **rena**

Median process of suranal plate short and stout, directed posteriorly; claspers movable (when removed from groove clasp, fig. 17), figs. 15, 17 12

12. Claspers long, slender and simple-curved, crossed apically; pigmented region of hypandrium a small isolated plate, longer than wide, fig. 15, **punctata**

Claspers long, triple-curved blades, not crossed; hypandrium thin and wide, extending between bases of claspers, fig. 17 .... **andra**

13. Suranal plate produced into small median, ventrally-curved hook, figs. 8, 42 14

Suranal plate almost evenly rounded 15

14. Claspers extending posteriorly almost touching, fig. 8 .... **pedicularia**

Claspers sickle-shaped extending postero-laterally, fig. 42 .... **chapmani**

15. Claspers forked at tip, fig. 1 .... **anna**

Claspers tapering to simple tip 16

16. Tips of claspers directed postero-laterally, fig. 4 .... **contraforcepeta**

Tips of claspers directed mesally 17

17. Claspers smoothly tapering, curves slight, fig. 2 .... **forcepeta**

Claspers distinctly curved as if twisted, fig. 3 .... **major**

18. Parameres asymmetrical, fig. 10 .... **kola**

Parameres symmetrical 19

19. Claspers crossed; suranal plate produced into small median hook, fig. 7 .. **pallida**

Claspers separated; suranal plate rounded, figs. 11, 43 20

20. Parameres flared posteriorly; claspers directed downward and antero-laterally, fig. 11 .... **jeanae**

Parameres slender, tapering at extremities; claspers directed postero-mesally, fig. 43 .... **nita**

FEMALES

1. Only two small flap-like tips of gonapophyses distinct beyond distal margin of subgenital plate; bases of gonapophyses apparently fused to dorsal interior plate, figs. 29–34 2

Gonapophyses large, distinct, thumb-like flaps; distal margin of subgenital plate (or ventral interior plate) extends posteriorly between gonapophyses, at least mesally, figs. 19–28, 36–40, 44 7

2. Posterior margin of subgenital plate with two wide lateral projections, figs. 29–30 3

Posterior margin of subgenital plate convex, fig. 34, almost straight, figs. 32, 33 or gently concave with a distinct median nick, fig. 31 4

3. Postero-lateral projections of subgenital plate darkly pigmented, mesally-directed hooks, fig. 29 .... **dona**

Postero-lateral projections of subgenital plate not more heavily pigmented than remainder of plate, truncate tips directed laterally, fig. 30 .... **punctata**

4. Ventral interior plate completely exposed externally posterior of subgenital plate, fig. 31 .... **kola**

Ventral interior plate completely internal, fig. 32 5

5. Forewings long and tapering, subhyaline, (terminalia, fig. 32) .... **andra**

Forewings of usual proportions, spotted at ends of veins 6

6. Subgenital plate and ventral interior plate distinct, anterior margin of ventral interior plate with distinct mesal notch, and obliquely truncate laterally, fig. 33 .... **nubilis**

Subgenital plate and ventral interior plate difficult to differentiate, fig. 34 .... **arnae**

7. Subgenital plate with an external median flap distally, figs. 25–28, 44 8

Subgenital plate without any external flap 12

8. Flap of subgenital plate a long slender prong, fig. 28 .... **corona**

Wide flap of subgenital plate forked distally, figs. 25–27, 44 9

9. Two heavily pigmented, longitudinal, internally-ridged structures on dorsal interior plate, fig. 27 .... **rufa**
   Dorsal interior plate lacking any heavily pigmented, internally-ridged structures 10
10. Flap of subgenital plate widest at base, fork extending half way to point of attachment with subgenital plate, fig. 26 .... **jeanae**
   Flap of subgenital plate widest distally, fork extending about one-fourth or less length of flap, figs. 25, 44 11
11. Distance between bases of gonapophyses less than greatest width of either base; posterior margin of subgenital plate abruptly emarginate mesally, fig. 44 .... **arida**
   Distance between bases of gonapophyses about twice the greatest width of either base; posterior margin of subgenital plate slightly concave, fig. 25 .... **silvicola**
12. Latero-distal corners of subgenital plate sunken and covered by overlapping gonapophyses (very distinct in stained specimens), figs. 19–22 13
   Latero-distal corners of subgenital plate curled under, fig. 39, or not sunken and covered by overlapping gonapophyses; subgenital plate sometimes overlaps part of gonapophyses, figs. 23–24, 37–40 16
13. Anterior limits of subgenital plate indistinct; pigmented portion of ventral interior plate lemon-yellow, horizontally oval, figs. 19–20 14
   Anterior limits of subgenital plate distinct, especially so laterally, cleft mesally; pigmented portion of ventral interior plate consisting of two small oblique lemon-yellow plates, fig. 22, or ventral interior plate not pigmented, fig. 21 15
14. Notch at anterior limits of ventral interior plate, with a small round protuberance on each side of notch, fig. 20 .... **forcepeta**
   Anterior margin of ventral interior plate horizontal mesally, without notch or protuberances, fig. 19 .... **major**
15. Pigmented portion of ventral interior plate consisting of two small, oblique, yellow-brown oval areas, fig. 22 .... **anna**
   Ventral interior plate not pigmented, fig. 21 .... **contraforcepeta**
16. Sense tubercles of paraprocts poorly developed, consisting of one to four sensory hairs; subapterous, fig. 35 .... **pallida**
   Sense tubercles well developed and conspicuous, subapterous to macropterous 17
17. Subgenital plate conspicuously narrowed posteriorly, extending between claspers almost to their tips, figs. 37–39 18
   Subgenital plate either almost evenly rounded posteriorly, or almost truncate with ventral interior plate external 20
18. Latero-distal corners of subgenital plate curled under causing distal end of subgenital plate to project from body, pigmentation pale, fig. 39, **chapmani**
   Latero-distal corners of subgenital plate not curled under, figs. 37, 38 19
19. Posterior margin of subgenital plate emarginate; proximally on subgenital plate two long pigmented areas laterally; ventral internal plate small and pale, fig. 37 .... **rena**
   Posterior margin of subgenital plate evenly rounded; ventral interior plate large and slightly pigmented, fig. 38 .... **penta**
20. Ventral interior plate small, pigmented posteriorly, distinctly visible through the subgenital plate, figs. 23, 24, or external and fused with subgenital plate, fig. 40 21
   Ventral interior plate not pigmented and not visible through the broad uniformly pigmented subgenital plate, fig. 36 .... **pedicularia**
21. Ventral interior plate external and extending to lateral margins of subgenital plate; two small, posterior, mesal, transparent projections on posterior margin of ventral interior plate, fig. 40 .... **nita**
   Ventral interior plate narrow, about one-third width of subgenital plate; subgenital plate almost evenly rounded posteriorly 22
22. Ventral interior plate with a triangular notch anteriorly; two longitudinal slightly pigmented regions on dorsal interior plate, fig. 23 .... **pacifica**
   Ventral interior plate with a notch posteriorly; no longitudinal pigmented regions on dorsal interior plate, fig. 24 .... **telsa**

DESCRIPTION[2] AND DISTRIBUTION OF SPECIES

Lachesilla andra new species

This is a slender light brown species superficially resembling ***kola*** but the terminalia indicate closer relationship with ***nubilis***. It differs from ***nubilis*** in being smaller and uniformly light brown, in having long slender wings and in the terminalia.

MALE.—Length of forewings, 1.9–2.7; width of head, 0.4–0.5; length of antennae, 1.2–1.4.

Head: Light brown, indefinite clouded area on vertex above eyes fading toward ocelli; so-called arms of epicranial suture distinct to antennal fossae; front light brown; ocelli almost white, lateral ocelli much larger than median one; ocellar interval light brown; clypeus and genae uniformly light brown; labrum paler; two basal segments of antennae light brown, remainder of antennae and maxillary palps darker.

Thorax: Light brown, anterior part of middle lobe of meso-thoracic scutum darker; pleura, sterna and legs light brown, legs darker distally. Wings almost hyaline; veins brown; pterostigma subhyaline and about six times longer than its greatest width.

Abdomen: Pale, almost white except for light brown terminalia, fig. 17. Sense tubercles darker brown; paraprocts with light brown posteriorly-directed ventral prongs approximately the same width throughout; suranal plate pale, produced into a single posteriorly-directed hook; parameres fused basally for about half their length forming a Y-shaped structure, expanded distally into thin lobed blades; claspers are triple-curved thin flat sclerotized blades; hypandrium is wide and very short, extending between the bases of the claspers.

FEMALE.—(Brachypterous and macropterous) length of forewings, 1.0–2.0; width of head, 0.45–0.45; length of antennae, 0.7–1.0.

The female is lighter than the male, hence the usual dotted areas of the vertex and lineations of the clypeus are more pronounced. The eyes and ocelli are smaller and the ocellar interval is pale.

Terminalia: Fig. 32. The sense tubercles are slightly darker than the other areas of the terminalia; the gonapophyses are small, pale flaps posterior of the subgenital plate; the central sclerotized portion of the subgenital plate is roughly diamond-shaped (visible in stained specimens); through the subgenital plate can be seen the tan sclerotized ventral interior plate, which is widely and deeply emarginate at its anterior margin; the dorsal interior plate is almost transparent.

Holotype ♂, Giant City State Park, Illinois, October 25, 1944 (sweeping grass) Ross and Sommerman, INHS. *Allotype* ♀, Same data as for holotype. *Paratypes.*—ARKANSAS: Washington Co., Aug. 12, 1942 (light trap) M. W. Sanderson ♂, INHS. CONNECTICUT: Mt. Carmel, Sept. 30, 1943 (sweeping dry grass) K. Sommerman 12 ♂, 5 ♀, KMS, A. H. Sommerman 6♂, 5♀, CU; Mt. Carmel, June 14, 1944

[2]Measurements are stated in millimeters. Those given in the descriptions are the extremes taken from measurements of ten random individuals of each sex, if that many were available. These measurements are included mainly to give some idea of the approximate size of the individuals concerned and are not to be interpreted as rigid limits of extremes.

(sweeping dry grass) A. H. Sommerman 5♂, 41♀, KMS; Mt. Carmel, Aug. 2, 1944 (sweeping grass) A. H. Sommerman ♂, 6 ♀, KMS; Mt. Carmel, Sept. 10, 1944 (sweeping grass) A. H. Sommerman 16 ♂, 9 ♀, KMS; Mt. Carmel, Oct. 9, 1944 (sweeping grass) A. H. Sommerman 7 ♂, 9 ♀, INHS; North Haven, Oct. 23, 1944 (*Andropogon*) A. H. Sommerman 5♂, 3 ♀, INHS. GEORGIA: Fort McPherson, Aug. 2–10, 1943 (light trap) H. Hoogstraal ♂, CNHM, same data but June 25, ♂, KMS; Athens, March 23, 1943 (broomsedge) Odum ♂, ♀, KMS; Cornelia, May 10, 1944 Frison and Ross ♀, INHS. ILLINOIS: Same data as for holotype, 17 ♂, 34 ♀; Lake Glendale, June 14, 1944 (sweeping *Andropogon*) Frison and Sanderson 34 ♂, 49 ♀ (10 ♂, 10 ♀ each USNM, CNM, UCB and 4 ♂, 19 ♀ INHS); Alto Pass, May 8, 1917 ♂, ♀, INHS; Pounds Hollow Lake, July 19, 1944 (on *Andropogon*) Ross and Leighton 3 ♂, 14 ♀, INHS; Olive Branch, Oct. 26, 1944 (on *Andropogon*) Ross and Sommerman 5 ♂, 4 ♀, INHS; Mounds, Oct. 25, 1944 (on corn) Ross and Sommerman ♀, INHS; Giant City State Park, July 6, 1944 (sweeping *Andropogon*) Sanderson and Leighton 8 ♂, 12 ♀, (on cedar) 3 ♂, 5 ♀, INHS; Castle Rock, July 13, 1944 (*Andropogon*) Frison and Sanderson 22 ♀, INHS; La Rue, July 21, 1944, Ross and Leighton 4 ♂, ♀, INHS; Elgin, Aug. 1, 1944 (sweeping) Ross and Sommerman 2 ♀, INHS; Cobden, Oct. 25, 1944 (on corn) Ross and Sommerman ♀, INHS; Thomson, May 25, 1945 (*Andropogon*) Ross and Sanderson ♀, INHS; Ware, Oct. 26, 1944 (on corn) Ross and Sommerman ♀, INHS; Gorham, Oct. 26, 1944 (on corn) Ross and Sommerman ♂, INHS; Sparta, Oct. 26, 1944 (*Andropogon*) Ross and Sommerman ♂, INHS; Herod, Oct. 24, 1944 (*Andropogon*) Ross and Sommerman 29 ♂, 40 ♀, KMS. INDIANA: Beaver Lake Prairie, May 18, 1941 (sweeping dry grass) K. Sommerman 23 ♂, 26 ♀, same data but May 10, 1942, 4 ♂, ♀, KMS; Evansville, June 18, 1943 H. Dybas 2 ♂, 3 ♀, CNHM.

Additional Records.—ILLINOIS: Dubois, May 24, 1917 ♀; Havana, July 5, 1946 (Sand Dunes) Sanderson and Burks ♀; Cottage Grove, Jan. 16, 1946 (in *Andropogon*) Ross and Burks N. MICHIGAN: Midland Co., Sept. 15, 1945 R. R. Dreisbach ♀. NEW JERSEY: Vineland, Sept. 1, 1939 (grass) J. C. Bradley 2 ♂, 2 ♀.

Lachesilla anna new species

This is a medium-size tan species superficially resembling *riegeli*, but the terminalia indicate closer relationship with *contraforcepeta* in the case of the male and *forcepeta* in the case of the female. Superficially it differs from the above-mentioned species in having the wings almost hyaline with very dark veins, cell Cu_{1a} very high and a dark lateral stripe from antennae to abdomen. The claspers of the male are forked at the apex and the interior ventral plate of the female possesses two conspicuously pigmented oval regions.

MALE.—Length of forewings, 1.8–2.1; width of head, 0.5–0.5; length of antennae, 1.6–1.8.

Head: Pale with white flecks, usual dotted areas on vertex distinct; front light brown and long, the clypeus being about as far from the median ocellus as the length of the distal segment of the maxillary palps;

ocelli inconspicuous; ocellar interval light brown; clypeus lineated with twelve mesally-directed tan bands; genae pale, two fuscous stripes extending from dorsal and ventral margin of antennal socket posteriorly to compound eye; labrum pale; antennae and maxillary palps light brown.

Thorax: Dorsum light brown with white spots along some of the sutures; pleura light brown with lateral fuscous stripe just above the base of the coxae; legs pale, especially the coxae and femora. Forewing subhyaline; pterostigma slightly less hyaline; veins dark brown; cell Cu_{1a} almost equilaterally triangular, with inner apex rounded; hind wing hyaline.

Abdomen: Pale ventrally but with prominent dark fuscous stripes extending from pleura across dorsum; terminalia, fig. 1, light brown fading to pale distally. Sense tubercles light brown; paraprocts pale; suranal plate almost evenly rounded; parameres pale, central shaft being several times longer than forks; claspers rounded at base (point of attachment to wider basal sclerite,) flattened distally to fork, inner fork bends dorsally, outer fork laterally; hypandrium rectangular and slightly pigmented.

FEMALE.—Length of forewings, 2.0–2.1; width of head, 0.5–0.5; length of antennae, 0.7–0.8.

The female is lighter than the male hence the lateral stripe and abdominal bands are very conspicuous.

Terminalia: Fig. 22. Sense tubercles are pale but bordered dorsally by a thin fuscous stripe; the gonapophyses are large, pale, mesally-directed flaps that are attached laterally about at the middle of the subgenital plate, overlapping the subgenital plate distally; subgenital plate very pale excepting for two lateral light brown patches at the anterior margin; through the subgenital plate can be see two oblique yellow-brown, oval regions of the ventral interior plate; dorsal interior plate transparent.

Holotype ♂, near Mayview, Illinois, University Woods, Oct. 15, 1944 (dried leaves) K. Sommerman, KMS. *Allotype* ♀, same data as for holotype. *Paratypes.*—CONNECTICUT: Storrs, Aug. 2, 1944 (dried oak leaves) A. H. Sommerman ♂, ♀, KMS; Mt. Carmel, Oct. 12, 1941 (beating Red Pine) K. Sommerman ♂, 3 ♀, (♂, ♀, UCB, 2 ♀,KMS). ILLINOIS: Same data as for holotype, 2 ♀, KMS; Urbana, Brownfield Woods, Sept. 27, 1941 (dried Hackberry leaves) K. Sommerman ♀, KMS, (dried oak leaves) ♀, INHS; Urbana, Oct. 8, 1944 (dried oak leaves) K. Sommerman ♀, KMS; La Rue, Oct. 26, 1944 (dried leaves) Ross and Sommerman ♀, INHS; Palisades State Park, July 14, 1944 (sweeping) Frison and Sanderson 2 ♂, ♀, INHS; Near Mayview, University Woods, Oct. 28, 1944 (oak and maple leaves) K. Sommerman ♂, KMS; Eichorn, Oct. 25, 1944 (dried leaves) Ross and Sommerman ♂, 2 ♀, (♂, ♀, USNM, ♀, INHS).

Lachesilla arida Chapman

Lachesilla arida Chapman (1930, p. 346). ♀.

Only one paratype of this species was available for critical study so the information here presented is almost entirely taken from Chapman, (l. c.).

FEMALE.—Length of forewings, 2.7 mm. av. of 4 indiv.; length of antennae, 2.1 mm. av. of 4 indiv.

This species resembles *silvicola* in general appearance and markings but can be distinguished from it by the veins in the proximal half of forewing being pale yellow, in the distal half brown; the subgenital plate being of definite outline with a basal cleft midway; the distance between bases of gonapophyses less than the greatest width of either base, the posterior margin of the subgenital plate abruptly emarginate mesally, terminalia, fig. 44.

Holotype ♀, Ramsey Canyon, Huachuca Mts., Arizona, Sept. 2, 1927 (in dried oak leaves) J. D. Hood, PJC.

Lachesilla arnae new species

This is a small light brown, spotted-winged species superficially resembling *rena* from which it may be readily distinguished by the bilobed suranal plate and curved, mesally-directed claspers of the male, and the subgenital plate almost completely covering the gonapophyses in the female.

The only specimens available for study were dried material that had been relaxed and cleared *in toto* in KOH; so the intensity of color is not available.

MALE.—Length of forewings, 1.5–1.8; width of head, 0.4–0.45; length of antennae, 1.2–1.4.

Head: Usual dotted areas of vertex distinct and brown; front light brown; ocelli and ocellar interval pale; clypeus with twelve mesally-directed, light brown bands; genae with clouded area below eyes; labrum pale; antennae and maxillary palps brown.

Thorax: Dorsum concolorous with brown areas on vertex, paling along sutures; anterior of middle lobe of mesothoracic scutum darker; pleura and legs light brown, tarsi darker. Forewings hyaline; veins delicate and light brown; pterostigma subhyaline; R and M fused for a distance; veins distinctly margined with bands of brown as follows: R_1 from middle of pterostigma distally, tips of all veins along margin of wing from R_1 to and including Cu_2, Rs to point of fusion with M, along M to point of separation of Cu_1. Hindwings hyaline; brown bordering along tips of R_{2+3}, R_{4+5}, M, Cu and Cu_2.

Abdomen: Pale, excepting for light brown terminalia, fig. 14. Sense tubercles brown; paraprocts with pronounced mesal, posteriorly-directed, blunt prongs; suranal plate bilobed; parameres fused basally to form a stout dark shaft, normally parameres entirely internal, if external then only the distal tips exposed; claspers light brown, slightly curved, almost uniform in width, mesally-directed and fused to basal sclerite; hypandrium broad, rectangular, light brown.

FEMALE.—(Brachypterous and macropterous) length of forewings, 0.5–1.7; width of head, 0.45–0.5; length of antennae, 0.9–1.2.

The female is similar to the male.

Terminalia: Fig. 34. Sense tubercles light brown; gonapophyses small, pale flaps with only the tips protruding posteriorly beyond subgenital plate; subgenital plate, ventral interior plate and dorsal interior plate all almost colorless and transparent.

Holotype ♂, Saskatoon, Saskatchewan, Canada, September 17, 1940 (sweeping native grassland) K. M. King, CNM. *Allotype* ♀, same data as for holotype but August 21. *Paratypes.*—SASKATCHEWAN: Same data as for holotype, ♂, ♀, KMS; Same data as for allotype, 3 ♂, 3 ♀, (♂, ♀, USNM, ♂, ♀, INHS, ♂, ♀, DELSS), same data but Sept. 3, 1940, 2 ♂, 2 ♀ (♂, ♀, DELSS, ♂, ♀, INHS).

Lachesilla chapmani new species

This is a small pale species superficially resembling *nita* from which both sexes may be readily distinguished by the terminalia; cell Cu_{1a} of median height and an interrupted dark ventral stripe from labium along inner margins of coxae to abdomen.

MALE.—Length of forewings, 1.4–1.6; width of head, 0.4–0.5; length of antennae, 1.6–1.7.

Head: Pale, including vertex, ocelli and ocellar interval, front, clypeus, genae and palps; antennae buff; compound eyes black and bulging; interrupted fuscous stripe extending across neck region from eye to base of wings; second interrupted fuscous stripe from base of maxillary palps posteriorly along sternal limits.

Thorax: Pale buff except for interrupted fuscous stripe extending posteriorly along dorsal and ventral margins of pleura; legs pale; forewings almost hyaline, veins pale; hind wings hyaline.

Abdomen: Pale with interrupted lateral fuscous stripe; terminalia, fig. 42, pale buff; suranal plate with small ventrally projecting hook; claspers sickle-shaped, projecting mesally, posteriorly, then laterally; parameres pale, central shaft several times longer than fork; hypandrium pale.

FEMALE.—Length of forewings. 1.6–1.8; width of head, 0.5–0.55; length of antennae, 1.5–1.5.

The color pattern of the females is similar to that of the males. The usual dotted areas on the vertex and the clypeal lineations are more distinct and the front is pale brown.

Terminalia: Fig. 39, pale, gonapophyses large, pale mesally-directed flaps; subgenital plate pale, postero-lateral margins turn in making posterior margin appear almost pointed from ventral view; ventral and dorsal interior plates transparent.

Holotype ♂, Ft. Myers, Florida, February 4, 1933 (dead palm fronds) P. J. Chapman, KMS. *Allotype* ♀, same data as for holotype. *Paratypes.*—FLORIDA: Same data as for holoytpe, 2 ♂, ♀ (♂, KMS, ♂, ♀, PJC); Silver Springs, Feb. 6, 1933 (dead shrubs and palms) P. J. Chapman 2 ♂, 2 ♀ (♂, ♀, INHS, ♂, ♀, USNM).

This species is named for Dr. P. J. Chapman in appreciation of his excellent co-operation during this study.

Lachesilla contraforcepeta Chapman

Lachesilla contraforcepeta Chapman (1930, p. 347). ♂, ♀.

This is a medium-size tan species with uniformly tan or salmon-colored wings, resembling *forcepeta.* For a complete description of color characters see Chapman, (l. c.).

MALE.—Length of forewings, 1.6–1.9; width of head, 0.5–0.55; length of antennae, 1.1–1.4.

Terminalia: Fig. 4. Sense tubercles brown; paraprocts pale brown; suranal plate gently rounded, pale brown; parameres fused at base, the central shaft slightly pigmented, external tips lobe-like and colorless; claspers pale tan, twice-bent (at first directed mesally, narrowing to bend, then posteriorly, almost uniform in width to next bend, then postero-laterally), tapering abruptly to tip, fused to elongate, brown, curved, basal sclerite; hypandrium pale brown, wider than long, completely covering area between basal sclerites of claspers.

FEMALE.—Length of forewings, 1.7–1.9; width of head, 0.5–0.55; length of antennae, 1.0–1.2.

Terminalia: Fig. 21. Sense tubercles brown; paraprocts pale, light brown at tips; gonapophyses pale brown, tips curved mesally overlapping postero-lateral corners of subgenital plate; subgenital plate pale brown, distinct in outline, with deep basal cleft mesally, ventral and dorsal interior plates transparent.

Holotype ♂, Ithaca, New York, August 22, 1926 (on Red Cedar) P. J. Chapman, PJC.

Records.—CONNECTICUT: Mt. Carmel, Aug. 10, 1944 (dried oak leaves) A. H. Sommerman ♂, ♀; Mt. Carmel, Oct. 14, 1941 (beating Red pine) K. M. Sommerman ♀. ILLINOIS: Giant City State Park, Monticello, Mt. Carroll, Nora, Palisades State Park, Urbana, Wauconda, White Pines State Park and Zion taken from spruce, cedar, *Andropogon*, pine, tamarack and dried leaves between June 8 and October 25. KANSAS: Lawrence, July 21, 1943 (beating cedar) M. W. Sanderson 16 ♂, 19 ♀. MARYLAND: Plummers Island, June 8, 1913 W. L. McAtee ♀. SASKATCHEWAN: Saskatoon, June 27, 1939 (sweeping grass) K. M. King ♀.

Lachesilla corona Chapman

Lachesilla corona Chapman (1930, p. 350). ♂, ♀.

This is a medium-size light brown species, with subhyaline wings having R_1 darker distally along pterostigma as in *pedicularia.* For a complete description of color characters see Chapman, (l. c.).

MALE.—Length of forewings, 2.1–2.3; width of head, 0.5–0.55; length of antennae, 1.6–1.7.

Terminalia: Fig. 12. Sense tubercles brown; paraprocts pale excepting for light brown postero-mesally-directed blunt prongs; suranal plate bilobed, pale, excepting for lateral extremities; parameres short, dark, fused basally for about one-third their entire length, each arm of the "Y" bearing an additional posteriorly-directed process about midway; claspers branched, pale, long, slender processes, outer branches postero-mesally-directed on the oblique, inner branches vary considerably in length, some are directed mesally and curved anteriorly not reaching median line of body, others almost reach median line, then are curved posteriorly with their tips almost touching tips of outer branches; hypandrium wide and short with brown basal sclerites of claspers (two

oblique ovals) fused postero-laterally; brown pigment on several anterior sclerites.

FEMALE.—Length of forewings, 2.0–2.3; width of head, 0.55–0.6; length of antennae, 1.4–1.5.

Terminalia: Fig. 28. Sense tubercles brown; paraprocts light brown mesally; gonapophyses tapering and directed postero-mesally, brown along outer margin, membranous and colorless along inner margin; subgenital plate brown with a long slender tapering prong mesally; ventral interior plate light brown, with a distinct notch in posterior margin, apparently fused posteriorly to the subgenital plate; dorsal interior plate pale, yellow-brown.

Holotype ♂, Spottswood, Virginia, October 4, 1926, Crosby and Bishop, PJC.

Records.—ARKANSAS: Hot Springs, June 19, 1943 T. H. Frison ♀; St. Francis Co., June 22, 1937 (peach orchard) Turner and Anderson ♂. CONNECTICUT: Mt. Carmel, Sept. 27, 1943 (sweeping dry grass) K. Sommerman ♂, ♀, Sept. 15, 1943 (dried leaves) A. H. Sommerman 9 ♂, 13 ♀, Sept. 30, 1943 (sifting dried leaves) K. M. and A. H. Sommerman ♀, Oct. 7, 1943 (dried leaves) K. M. and A. H. Sommerman ♂, 6 ♀. GEORGIA: Putnam Co., Sept. 5, 1936 (on peach foliage) W. F. Turner ♀. ILLINOIS: Apple River Canyon, Bayview, Cairo, Cobden, Eichorn, Elgin Botanical Garden, Enfield, Giant City State Park, Gorham, Grayville, Homer, Keithsburg, La Rue, Makanda, Mayview, Monticello, Mounds, Muncie, Olive Branch, Sherman, Urbana, Ware, and Weldon Springs taken from dried leaves, *Andropogon*, corn, ground-cover and dried brush between May 23 and October 28. INDIANA: Knox Co., July 20, 1938 (peach foliage) W. F. Turner ♂. KANSAS: Lawrence, July 21, 1943 (dried Redbud leaves) M. W. Sanderson ♂, 4 ♀, (dried ash leaves) ♀, beating(cedar) ♀; Lawrence, Oct. 17, 1944 R. H. Beamer 2 ♂, 2 ♀; Douglas Co., Nov. 2, 1944 R. H. Beamer ♀; Onaga (no date) Crevecoeur ♂. MICHIGAN: Cheboygan Co., July 1, 1935 H. B. Hungerford ♂. PENNSYLVANIA: Kenneth Square, Sept. 28, 1939 (ex leaf mould) A. C. Davis ♀. TENNESSEE: Paris, Aug. 11–15, 1943 (light trap) R. L. Wenzel 5 ♂. VIRGINIA: Albemarle Co., June 15, 1940 (from peach) W. F. Turner ♀.

Lachesilla dona new species

This is a large spotted-wing species resembling *punctata* but can be easily distinguished from it by the two lateral projections of the suranal plate and the claspers that do not cross, in the male and by the postero-lateral projections of the subgenital plate produced into two postero-mesally directed hooks in the female.

MALE.—Length of forewings, 2.8–3.0; width of head, 0.55–0.6; length of antennae, 1.9–2.2.

Head: Brown, with the usual spotted areas a darker brown; a pale C-shaped mark extending from base of antennae to ocelli posteriorly almost to posterior margin of vertex where it turns and extends laterally to the eye; so-called arms of epicranial suture distinct to antennal fossae; front brown; ocelli almost white; ocellar interval light brown;

clypeus with fourteen mesally-directed brown bands that almost merge to make a uniformly brown clypeus; genae and labrum light brown; antennae and maxillary palps brown, darkest distally.

Thorax: Brown, pale along dorsal sutures, two darker areas on anterior part of middle lobe of mesothoracic scutum; pleura light brown with sutures dark; legs brown, tarsi darkest. Forewings subhyaline; veins brown, darkest distally; clouded spot at end of all veins excepting Cu_{1b}, clouded region extending far along Cu_{1a}, dark brown spot at end of Cu_2; hindwings almost hyaline with brown veins excepting Cu_2 and 1A, which are colorless; clouded area at end of veins, anterior margin of cell C brown, a distinct brown spot at apex of cell Cu_2.

Abdomen: Pale, with slight indications of stripes, excepting for strongly pigmented terminalia, fig. 16. Sense tubercles light brown but strongly pigmented around base; paraprocts with dark brown, almost black, ventral, posteriorly-directed, flared and flattened prongs with a strongly concave distal margin; suranal plate pale, almost white excepting for brown distal extremities, produced into two prominent lateral, posteriorly-directed projections, each of which bears a smaller ventral protuberance; parameres fused basally for a little more than half their entire length, distally they become complicated "hand-shaped" (with thumb above palm) structures; claspers are curved, slightly mesally-directed, darkest distally and when in place they fit under the parameres near the tip; hypandrium long, conical with rounded cap and extending between the bases of the claspers.

FEMALE.—Length of forewings, 2.4–2.7; width of head, 0.55–0.6; length of antennae, 1.5–1.8.

The female is a little lighter than the male and the pale markings on the head are larger; the so-called arms of the epicranial suture are indistinct and almost touch the clypeus; the eyes are about two-thirds as large as those of the male.

Terminalia: Fig. 29. The terminalia are heavily pigmented and very distinct. The sense tubercles are brown on pale paraprocts; gonapophyses small light brown flaps, darkest basally; posterior margin of subgenital plate produced into two strongly sclerotized and pigmented mesally-directed hooks; subgenital plate less pigmented along mesal line and more transparent; through the subgenital plate can be seen the sclerotized and pigmented ventral interior plate with a mesal fold and mesal projections at anterior margin; dorsal interior plate pigmented excepting in the mesal area with posterior lateral corners drawn out into very distinct brown points.

Holotype ♂, near Hollywood, California, Topanga Canyon, December 25, 1941 (sweeping grass and shrubs) Sommerman and Hasbrouck, KMS. *Allotype* ♀, same data as for holotype. *Paratypes.*—CALIFORNIA: Same data as for holotype, 9 ♂, 9 ♀ (♂, ♀, each INHS and UCB, 7 ♂, 7 ♀, KMS); La Jolla, July 13, 1941 R. H. Beamer ♂, KU; Glenora Angeles Nat. Forest (meadow) July 15, 1944 Shelford et al ♂, ♀, INHS; Hemet, Jan. 13, 1938 (cover sweepings) Christenson and Jones ♂, USNM; Hemet, July 15, 1938 (on peach) Christenson and others ♂, ♀, USNM; Hemet, April 11, 1940 (on peach) Christenson et al ♀, USNM; Yucapia, May 11, 1938 (on peach) Christenson et al ♀, USNM.

Lachesilla forcepeta Chapman

Lachesilla forcepeta Chapman (1930, p. 348). ♂, ♀.

This is a medium-size tan species resembling *contraforcepeta*. For a complete description of color characters see Chapman, (l. c.).

MALE.—Length of forewings, 1.5–1.8; width of head, 0.45–0.5; length of antennae, 1.3–1.5.

Terminalia: Fig. 2. Similar in general to *contraforcepeta* excepting for claspers being wide at base, tapering abruptly at about one-third their length then gently tapering to tip which is bent postero-mesally; basal sclerite to which claspers are fused, pale.

FEMALE.—Length of forewings, 1.6–1.8; width of head, 0.45–0.55; length of antennae, 1.1–1.2.

Terminalia: Fig. 20. Sense tubercles brown; paraprocts pale; gonapophyses pale, curved and tapering toward blunt tip, overlapping dorso-lateral corners of subgenital plate; subgenital plate indefinite in outline anteriorly, sometimes pigmented laterally; pigmented region of ventral interior plate a lemon-yellow oval, anterior to this the ventral interior plate is colorless, its anterior margin obliquely tapering mesally where there is a median notch on either side of which is a small dark protuberance (visible sometimes in unstained material); dorsal interior plate colorless.

Holotype ♂, Sea Cliff, Long Island, New York, September 6, 1925 (on dead oak leaves) P. J. Chapman, PJC.

Records.—CONNECTICUT: Mt. Carmel, Oct. 14, 1941 (beating Red pine) K. M. and A. H. Sommerman 8 ♂, 6 ♀, Oct. 12, 1941 3 ♂, 4 ♀; Mt. Carmel, Oct. 4, 1944 (spruce and sweet fern) A. H. Sommerman ♀; Mt. Carmel, Sept. 30, 1943 (beating Red pine) K. M. and A. H. Sommerman ♂, ♀. ILLINOIS: Apple River Canyon, Dongola, Freeport, Giant City State Park, Hillsboro, Momence, Mt. Carroll, Pounds Hollow Lake, Starved Rock State Park, Urbana, Wauconda, White Pines State Park and Zion taken from spruce, juniper, yew, pine, *Andropogon* and grass between May 10 and October 25. KANSAS: Lawrence, July 21, 1943 (beating cedar) M. W. Sanderson ♂, ♀. MARYLAND: Plummers Island, June 8, 1913 W. L. McAtee ♀. MISSOURI: Columbia, June, 1941 (on arm) P. C. Stone ♀. TENNESSEE: Clarksville, July 1, 1939 R. H. Beamer ♀.

Lachesilla jeanae new species

This is a medium-size tan species superficially resembling *contraforcepeta* from which it can be easily distinguished by the non-fused parameres in the male and the posterior flap on the subgenital plate in the female.

MALE.—Length of forewings, 2.2–2.4; width of head, 0.55–0.6; length of antennae, 1.9–2.1.

Head: Pale, with usual clouded areas on vertex light brown; arms of epicranial suture indistinct; front light brown; ocelli pale, median ocellus larger; ocellar interval clouded; clypeus pale with mesally-directed bands indistinct making entire clypeus appear slightly darker than pale areas above antennae; genae pale with clouded area below eye;

fuscous bands extending from dorsal and ventral margin of antennal fossae to eye; small dark area behind eye; labrum pale brown; antennae and maxillary palps light brown.

Thorax: Pale, anterior part of middle lobe of mesothoracic scutum light brown; lateral lobes light brown; pleura pale with faint indications of two lateral stripes, one just below base of wings, other just above base of coxae; legs pale, tarsi light brown. Wings hyaline; pterostigma almost hyaline; veins light brown.

Abdomen: White, with incomplete fuscous stripes extending laterally almost across the dorsum; terminalia, fig. 11, light brown, especially so ventrally; several sternites anterior to hypandrium also light brown. Sense tubercles light brown; paraprocts pale with a small, light brown mesally-directed, pointed prong; suranal plate rounded; parameres separate, widened and flattened distally with several curves and finally tapering to a long tip; claspers short, twisted, inconspicuous processes directed downward and antero-laterally; hypandrium wide and rectangular.

FEMALE.—(Brachypterous) length of forewings, 1.0–1.4; width of head, 0.5–0.65, length of antennae, 1.3–1.7.

The female is a little lighter than the male.

Terminalia: Fig. 26. Sense tubercles brown; paraprocts pale; gonapophyses pale, conspicuous flaps, widest basally and tapering toward tip; subgenital plate large and sclerotized, more heavily pigmented near its latero-anterior margin where there are two swellings, with an external median flap posteriorly which is forked about half way from base to top and is widest at its point of attachment; ventral interior plate fused externally to posterior margin of subgenital plate, posterior of base of flap; dorsal interior plate somewhat sclerotized but not heavily pigmented.

Holotype ♂, Midland, Colorado, Four-mile Creek, August 8, 1943 (Limber pine) J. A. and H. H. Ross, INHS. *Allotype* ♀, same data as for holotype. *Paratypes.*—COLORADO: Same data as for holotype, 20 ♂, 13 ♀ (15 ♂, 8 ♀, INHS, 2 ♂, 2 ♀, each USNM, KMS and ♂, ♀, UCB); Woodland Park, Aug. 4, 1943 (bark of Colorado blue spruce) H. H. and J. A. Ross ♀, INHS.

Records.—COLORADO: Grant (Geneva Park) Aug. 19, 1914 E. C. Jackson 2 ♂; Pingree Park, Aug. 20, 1924 C. R. Crosby ♀. NEW MEXICO: Las Vegas, August and November, 1908 H. S. Barber 3 ♂.

This species is named after Mrs. Jean A. Ross, who has collected many Corrodentia in order to further this study.

Lachesilla kola new species

This is a slender tan species superficially resembling *andra* from which it can be distinguished by the asymmetrical parameres of the male and the external position of the ventral interior plate of the female.

MALE.—Length of forewings, 2.5–2.8; width of head, 0.45–0.5; length of antennae, 1.5–1.9.

Head: Pale, with usual dotted areas tan; ocelli white with black crescents on inner margins; ocellar interval pale connecting with customary light markings resulting in a pale "TT" on the vertex; front

tan; clypeus with eight indistinct, tan, mesally-directed bands (bands fused laterally); genae, maxillary palps and antennae tan; labrum pale.

Thorax: Dorsum tan, pale at sutures; pleura pale, sutures dark; legs pale. Forewings subhyaline; veins tan, with a faint indication of cloudiness at distal ends of veins; hindwings hyaline.

Abdomen: Pale, faintly ringed with dark stripes which fade out ventrally, with tan terminalia, fig. 10. Sense tubercles tan; paraprocts pale with pointed tan, mesally-directed prongs, basally two long slender sclerotized regions; suranal plate pale, bilobed; parameres long, slender, slightly curved, asymmetrical structures, flattened distally and tapering to a point, the left one being hooked basally; claspers (?) posteriorly-directed prongs fused to the hypandrium which is more heavily pigmented laterally.

FEMALE.—Length of forewings, 2.0–2.1; width of head, 0.4–0.5; length of antennae, 1.0–1.1.

The female is similar to the male in markings, but the eyes and ocelli are smaller.

Terminalia: Fig. 31. Tan and distinct, especially so ventrally. Sense tubercles tan; paraprocts pale; gonapophyses small pale flaps posterior of subgenital plate; subgenital plate pigmented laterally and posteriorly, posterior margin concave, with a little flange either side of the center, resulting in a median nick; ventral interior plate wide, completely exposed posteriorly of the subgenital plate, with a slight median carina proximally; dorsal interior plate almost colorless.

Holotype ♂, Ontario, California, October 21, 1938 (on peach) Christenson et al, USNM. *Allotype* ♀, Mesilla Park, New Mexico, December 4, 1939 (cover crop in peach orchard) L. D. Christenson, USNM. *Paratypes.*—CALIFORNIA: Ontario, Oct. 12, 1937 (from peach) Christenson and Jones, 3 ♂, 4 ♀ (♀, USNM, ♂, 2 ♀, INHS, ♂, KMS, ♂, ♀, UCB); Banning, Oct. 4, 1937 (alfalfa) Christenson and Jones, ♂, USNM. NEW MEXICO: Same data as for allotype, ♀, KMS. UTAH: Moab, Sept. 15, 1943 G. F. Knowlton, ♂, INHS.

Lachesilla major Chapman

Lachesilla forcepeta var. *major* Chapman (1930, p. 349). ♂, ♀.

This species resembles *forcepeta.* For a complete description of color characters see Chapman, (l. c.).

MALE.—Length of forewings, 1.9–2.0; width of head, 0.5–0.55; length of antennae, 1.6–1.8.

Terminalia: Fig. 3. Similar to *forcepeta* excepting that claspers are narrow at base with distal curve shorter and more pronounced than basal curve.

FEMALE.—Length of forewings, 2.0–2.1; width of head, 0.55–0.6; length of antennae 1.4–1.5.

Terminalia: Fig. 19. Similar to *forcepeta* excepting that anterior margin of colorless portion of ventral interior plate simple, without a notch and two lateral protuberances.

Holotype ♂, Spottswood, Virginia, Oct. 4, 1926 Crosby and Bishop.

Records.—ARKANSAS: Howard Co., Sept. 27, 1937 (peach foliage) Turner and Anderson ♂; Pike Co., Oct. 15, 1936 (peach foliage) Turner

and Anderson ♂. CONNECTICUT: (All records are from Mt. Carmel, collected by K. M. and A. H. Sommerman) Oct. 4, 1942 (dried oak leaves) ♂, ♀; Oct. 9, 1944 (sweeping grass) ♀; Sept. 23, 1944 (sifting leaves) ♀; Oct. 7, 1943 (dried leaves) ♂; Oct. 4, 1943 (spruce and sweet fern) 2 ♂, 3 ♀; Aug. 10, 1944 (dry oak leaves) ♂; Dec. 30, 1939 (dried corn in field) ♀. ILLINOIS: Cairo, Carlisle, Eichorn, Havana, Lake Forest, La Rue, Mayview, Palisades State Park, Shady Rest, Union County, Urbana, Weldon Springs, and White Pines State Park taken from dried corn, dried leaves, in house and at light between June 3 and November 8. MISSOURI: Stoddard Co., June 1, 1937 Turner and Anderson ♀. NEW YORK: Long Pond (Suffolk Co.) Sept. 19, 1926 ♂. NORTH CAROLINA: Nautahala Gap (Macon Co.) Oct. 16, 1926 Crosby and Bishop ♀.

Lachesilla nita new species

This is a medium-size tan species superficially resembling *anna* from which both sexes may be readily distinguished by the terminalia and the light tan wing veins.

MALE.—Length of forewings, 1.7–1.8; width of head, 0.5–0.55; length of antennae, 1.5–1.6.

Head: Pale, usual dotted areas on vertex distinct; front light tan and slightly longer than width of an ocellus, ocelli pale; ocellar interval light tan but fuscous along inner edge of ocelli; clypeus lineated, paler posteriorly; genae pale, two fuscous stripes extending from dorsal and ventral margin of antennal socket posteriorly to compound eye; labrum, antennae and maxillary palps light tan.

Thorax: Dorsum pale mesally, with indefinite light brown stripe on scutum; pleura light brown with lateral fuscous stripe just above base of coxae and a second from eye to wing base; legs pale, especially the coxae and femora. Forewings subhyaline; pterostigma less hyaline; veins light brown with tendency toward cloudiness in cells toward vein tips; cell Cu_{1a} high; hindwing hyaline.

Abdomen: Pale ventrally but with prominent stripes extending from pleura across dorsum; terminalia, fig. 43, light tan; sense tubercles and paraprocts light tan, pale prongs of paraprocts mesally-directed; suranal plate rectangular, but because of curvature it appears to be evenly rounded; parameres pale, slender and curved; claspers fused to hypandrium; hypandrium pale with transverse median groove, very evident in lateral view.

FEMALE.—Length of forewings, 1.9–2.0; width of head, 0.55–0.6; length of antennae, 1.3–1.5.

The color pattern of the female is the same as the male but the color intensity is not so pronounced.

Terminalia: Fig. 40. Pale, gonapophyses medium-size flaps with postero-mesally-directed prong on distal margin; subgenital plate pale with pigmented lateral areas; ventral interior plate (with two mesal points on distal margin) external and fused to posterior margin of subgenital plate; dorsal interior plate transparent.

Holotype ♂, Apopka, Florida, February 6, 1933 (live oak and willow oak) P. J. Chapman, KMS. *Allotype* ♀, Same data as for holotype.

Paratypes.—FLORIDA: same data as for holotype ♂, 3 ♀ (♂, ♀, PJC, 2 ♀, INHS); Lake Jackson, Leon Co., April 12, 1927 C. R. Crosby ♀, PJC. GEORGIA: Savannah, Jan. 31, 1933 (dead limb) P. J. Chapman ♀, KMS.

Lachesilla nubilis (Aaron)

Caecilius nubilis Aaron (1886, p. 13).
Lachesilla nubilis Chapman (1930, p. 351). ♂, ♀.

This is a rather large brown spotted-winged species resembling *punctata*. For a complete description of color characters see Chapman, (l. c.).

MALE.—Length of forewings, 2.2–2.5; width of head, 0.6–0.6; length of antennae, 1.7–1.8.

Terminalia: Fig. 18. Sense tubercles dark brown; paraprocts brown, with strongly sclerotized, posteriorly-directed, short, pointed, mesal prongs; suranal plate with two pale lateral lobes; parameres fused basally, sometimes basal tip broad, forked external part of parameres complicated and lobed with innermost part tapering posteriorly to a rounded point, the whole becoming external about one-half way up length of claspers; claspers sclerotized, light tan, twice-curved, posteriorly-directed blades, attached basally to a pincer-shaped basal sclerite; hypandrium brown, drawn out laterally at base, not covering entire distance between bases of claspers.

FEMALE.—Length of forewings, 2.1–2.3; width of head, 0.55–0.6; length of antennae, 1.4–1.6.

Terminalia: Fig. 33. Sense tubercles brown; paraprocts pale; gonapophyses small light brown flaps posterior of subgenital plate; subgenital plate broad, brown laterally, pale mesally; ventral interior plate shows through subgenital plate very plainly, light brown with anterior margin obliquely truncate laterally and a distinct median notch; dorsal interior plate light brown with postero-lateral angles drawn out into a point.

Holotype, Southern Texas (beating live oak thicket) Aaron, PANS.

Records.—ALABAMA: Escambia Co., March 10, 1937 Turner and Anderson ♀. ARKANSAS: Washington Co., Aug. 12–28, 1942 (light trap) M. W. Sanderson 11 ♂, 4 ♀, July 10–29, 1940 (light trap) M. W. Sanderson 3 ♂; Fayetteville, Aug. 16, 1941 (at light) M. W. Sanderson ♀; Howard Co., May 13, 1938 (weeds in orchard) W. F. Turner ♂; Howard Co., Dec. 8, 1938 W. F. Turner ♀; Howard Co., April 9, 1937 (weeds) W. F. Turner ♂, ♀; Howard Co., Sept. 24, 1937 (weeds) Turner and Anderson ♂; Washington, March 24, 1938 (sweeping) W. F. Turner ♀. COLORADO: Woodland Park Aug. 4, 1943 H. H. Ross ♀. CONNECTICUT: Mt. Carmel, Sept. 30, 1943 (dried corn) K. M. and A. H. Sommerman ♀. GEORGIA: Fort McPherson, June 3–Sept. 2, 1943 (light trap) H. Hoogstraal 48 ♂, 20 ♀; Cornelia, May 10, 1944 Frison and Ross 2 ♂, 7 ♀; Gainesville, May 9, 1944 Frison and Ross 2 ♂, 4 ♀; Peach Co., April 28, 1937 Turner and Anderson ♀; Upson Co., March 5–7, 1938 (peach orchard) W. F. Turner ♂. ILLINOIS: Throughout the state taken from dry organic material between April 4 and Dec. 12. INDIANA: Evansville, June 21, 1943 (at light) H. Dybas ♂; Beaver Lake Prairie, May 18, 1941 (sweeping dry grass) K. Sommer-

man 9 ♀; Jackson Co., June 27, 1938 (on willow) B. E. M. ♂. IOWA: County No. 35, Aug. 24, 1933 Barker ♀. KANSAS: Bloom, Douglas County, Harper County, Lawrence, Manhattan, Meade County, Medora, Onaga, Pratt, Riley County and Sedan taken from grass, corn, wheat, yucca pods and at light between April 17 and Nov. 11. KENTUCKY: Wickliffe, April 15, 1941 (floodplain sweeping) K. Sommerman 2 ♂; Sturgis, July 4, 1941 J. S. Ayars ♀. LOUISIANA: Tallulah, Aug. 30, 1934 (ex. cotton) P. M. Gilmer ♂; Tallulah, Nov. 6, 1929 (3,000 ft. airplane insect trap) P. A. Glick ♀; Bossier Parish, April 12, 1937 W. F. Turner ♂. MICHIGAN: Paw Paw, Aug. 31, 1942 J. S. Ayars ♂; Hart, June 19, 1939 C. W. Sabrosky ♂; Cheboygan Co., July 14, 1940 R. I. Sailer ♀; Shelby, June 21, 1939 C. W. Sabrosky ♂; Breedsville, 1929 N. Fuller ♂. MINNESOTA: St. Paul, Aug. 17, 1921 W. E. Hoffman ♂. MISSISSIPPI: Lincoln Co., March 10, 1939 (peach orchard) W. F. Turner ♀. MISSOURI: For the following nine localities all from corn in the field taken by T. F. Winburn; 7 mi. E. of Carrolton, Oct. 22, 1940 11 ♂, 15 ♀; Hannibal, Oct. 29, 1940 ♂, 3 ♀; High Hill, Oct. 15, 1940 ♂, 4 ♀; 2 mi. S. of Jacksonville, Oct. 15, 1940 8 ♂, 9 ♀; Keytesville, Oct. 21, 1940 8 ♂, 7 ♀; Lamine, Oct. 17, 1940 6 ♂, 5 ♀; Montgomery City, Oct. 15, 1940 23 ♂, 33 ♀; Norborne, Oct. 22, 1940 27 ♂, 22 ♀; and Richmond, Oct. 22, 1940 38 ♂, 19 ♀; Columbia, July 30, 1940 (on corn) P. C. Stone ♀; Palmyra, Sept. 4, 1940 G. T. Riegel 2 ♂; Macon, June 8, 1941 H. Dybas 2 ♂, 2 ♀; Boschertown, May 4, 1932 (on *Helianthus annuus*) Satterthwait 2 ♂; and Scott Co., Nov. 9, 1937 (under leaves) W. F. Turner ♀. NEW MEXICO: Tucumcari, Jan. 3, 1942 (sweeping sunflower) K. Sommerman ♂; Albuquerque, March 3, 1928 (cover sweeping) Christenson and Jones 3 ♂, 3 ♀. NORTH CAROLINA: For the following four records all from Raleigh taken by H. F. Schoof, Sept. 15, 1940 (dried corn) ♀; Jan. 6, 1941 (cotton bolls) ♂♂, ♀♀; March 15, 1941 (okra) 21 ♂, 34 ♀; March 12, 1941 (dried corn) ♂♂, ♀♀; Swain, May 10, 1944 Frison and Ross ♂, ♀; Raleigh, May 5, 1934 C. S. Brimley ♀; Raleigh, Aug. 7, 1938 Wilson ♂; Reidsville, June 27, 1905 (in wheat straw) F. Sherman ♀. OHIO: Mt. Healthy, May, 1942 (light trap) 3 ♂. OKLAHOMA: Comanche Co., (13) 3 ♂, 4 ♀. SOUTH CAROLINA: Columbia, July 10, 1943 (light trap) H. Hoogstraal ♂, 2 ♀; Clemson College, April 4, 1934 ♂; Saluda Co., June 22, 1938 W. F. Turner 2 ♀; Saluda Co., March 3, 1938 W. F. Turner (from peach) ♀. SOUTH DAKOTA: Brookings, Aug. 30, 1943 (light trap) H. C. Severins ♂. TENNESSEE: Sandburg, April 14, 1941 (sweeping shrubs) K. Sommerman 3 ♂, ♀; Parksville, April 25, 1938 Ross and Burks ♂; Sevierville, June 12, 1940 Frison et al ♂; Paris, June 21–Aug. 15, 1943 (at light) R. L. Wenzel 50 ♂, 14 ♀; Harriman, 1933 H. G. Butler 2 ♂; Roane Co., Dec. 15, 1936 Turner and Anderson ♂. TEXAS: Fort Worth, Feb. 5–10, 1944 (sweeping old vegetation and cotton) J. E. Porter 6 ♂, 11 ♀; Brownwood, June 7, R. H. Painter ♀; Dallas, Sept. 20, 1906 F. C. Pratt ♀; Dallas, Feb. 27, 1908 (on window) E. S. Tucker ♀; Dallas, March 16, 1908 F. C. Bishop ♀; Calvert, Feb. 27, 1908 C. R. Jones 2 ♂, 4 ♀; Victoria, J. D. Mitchell ♂; Texarkana, March 28, 1908 (on corn) E. S. Tucker ♀; Denison, July 7, 1939 (cover sweeping) Christenson and Jones ♂; Bangs, Feb. 16, 1939 (cover sweeping) L. S. Jones 6 ♂, ♀; Tyler, Feb. 23, 1938 (cover sweeping)

Christenson and Jones ♀. UTAH: Moab, Sept. 15, 1943 G. F. Knowlton ♂; Green River, June 14, 1945 G. F. Knowlton ♂; Orangeville, Sept. 6, 1945 (on alfalfa) G. F. Knowlton ♂. VIRGINIA: Danville, May 3, 1944 (at light) Frison and Ross ♂, 4 ♀; Arlington Farms, Aug. 19, 1932 (on corn) J. V. Scrivener ♂. SASKATCHEWAN: Saskatoon, Sept. 17, 1940 (native grassland) K. M. King ♀.

Lachesilla pacifica Chapman

Lachesilla pacifica Chapman (1930, p. 353). ♀.

This is a medium-size light brown species superficially resembling *contraforcepeta*. For a complete description of color characters see Chapman, (l. c.).

FEMALE.—Length of forewings, 1.6–1.9; width of head, 0.5–0.5; length of antennae, 1.0–1.2.

Terminalia: Fig. 23. Sense tubercles brown; paraprocts light brown; gonapophyses light brown, darker along outside margin, curved mesally; subgenital plate broad, pale, posterior margin curved with gentle median concavity; ventral interior plate distinct brown, at posterior margin of subgenital plate, with a triangular anterior cleft; dorsal interior plate colorless excepting for two pale stripes one on either side medianly, anterior of the ventral interior plate.

Holotype ♀, Seattle, Washington, August 7, 1927, C. R. Crosby, PJC.

Records.—CALIFORNIA: Yuba City, Sept. 19, 1938 (on peach) Christenson et al ♀; Berkeley, April 11, 1943 (apricot tree) C. A. Fleschner ♀. COLORADO: Buena Vista (Collegiate Peaks) Aug. 5, 1943 J. A. and H. H. Ross ♀. BRITISH COLUMBIA: Kaslo, Aug. 1 R. P. Currie 2 ♀; University, Oct., 1928 G. J. Spencer 5 ♀.

Lachesilla pallida (Chap.)

Terracaecilius pallidus Chapman (1930, p. 343). ♀.

This is a rather large brown species most closely related to *pedicularia* but can be easily distinguished from it by its large size. In the male the distal half of pterostigma is pigmented, a fumose band extends from Cu_{1a} to M, and the claspers are crossed. The sense tubercles of the female are inconspicuous and she is almost apterous, the wings being reduced to thick fleshy pads.

MALE.—Length of forewings, 1.9–2.3; width of head, 0.6–0.6; length of antennae, 1.7–1.9.

Head: Brown, usual spotted areas of vertex distinct; front brown; ocelli white; ocellar interval almost black; clypeus and genae brown, a little lighter along margin; labrum, antennae and maxillary palps brown.

Thorax: Dorsum dark brown; pleura lighter; legs same as antennae, brown. Forewings hyaline; veins brown; pterostigma opaque, distal half brown; clouded at tip of veins at margin, fumose along both sides of vein Cu_{1a} and extending across to M, distinct brown spot at end of Cu_2.

Abdomen: Pale, ringed with dark brown stripes across dorsum and continued ventrally across the sternites, but not so dark; terminalia, fig. 7, brown. Sense tubercles brown; paraprocts pale excepting for two

light brown areas mesally below sense tubercles, which bear postero-mesally-directed slender prongs; suranal plate produced into a small median, postero-ventrally-directed hook; parameres separate, tips at base very close; claspers, short brown crossed hooks; hypandrium dark brown and wide, fused to basal sclerites of claspers; anterior sternite brown.

FEMALE.—(Subapterous) length of forewings, 0.25–0.3; width of head, 0.6–0.65; length of antennae, 1.4–1.7.

Agrees in general with Chapman's description excepting that the legs are armed with ctenidia and sense tubercles of the paraprocts are inconspicuous, consisting of from one to four sense hairs on membranous circles; forewings are somewhat like nymphal wing pads with a few scattered hairs; posterior wings reduced to tiny protrusions lying beneath forewings.

Terminalia: Fig. 35. Concolorous with head; sense tubercles near dorsal basal corner of paraprocts; gonapophyses brown, arm-like, tapering at end but bluntly pointed; subgenital plate broad, convex, with drawn-out ends at base, apically blunt-pointed and non-pigmented; interior plates transparent.

Holotype ♀, Ithaca, New York, July 12, 1925 P. J. Chapman, PJC. *Allotype* ♂, Urbana, Illinois, October 16, 1944 (sifting leaves) K. Sommerman, KMS.

Records.—ILLINOIS: Urbana, Oct. 7, 1944 (sifting leaves) K. Sommerman 3 ♂, 3N♂; Urbana, Sept. 17, 1944 (sifting) K. Sommerman 5 ♂, 19 ♀, 17N♂, 16N♀; N of Mayview, Oct. 1, 1944 (sifting leaves) K. Sommerman ♀, N♂; Apple River Canyon State Park, Aug. 11, 1944 (ground cover) Sanderson and Leighton ♀; Muncie, Sept. 24, 1944 (sifting leaves) Ross and Sommerman ♂, ♀, 2N♀; Urbana, Sept. 17, 1944 (sifting leaves) K. Sommerman 2 ♂, 7 ♀; Urbana, Sept. 24, 1944 (sifting leaves) K. Sommerman 11 ♀, 24N♀; Urbana, Oct. 16, 1944 (sifting leaves) K. Sommerman 2 ♂, 4 ♀, N♂; Urbana, Oct. 14, 1944 (sifting leaves) K. Sommerman 2 ♂, 6 ♀, 2N♀; Clayton, Sept. 30, 1916 ♂; White Heath, June 24, 1916 ♂; Hopedale, Oct. 2, 1917 ♂; Urbana, July 22, 1945 (sifting) K. Sommerman 2 ♀, 2N♂, N♀; Urbana, July 29, 1945 (sifting) K. Sommerman 2 ♀. NEW YORK: Ithaca, July 12, 1925 P. J. Chapman 2 ♀.

Lachesilla pedicularia (L.)

Hemerobius pedicularius Linnaeus (1758, p. 551).
Termes fatidicum Linnaeus (1758, p. 610). (See Gurney, 1939).
Lachesilla pedicularia Chapman (1930, p. 384). ♂, ♀.

A nearly complete synonymy of this species appears in Enderlein, 1915.

This is a small to medium-size brown species with hyaline wings darkly veined. For a complete general description see Chapman, (l. c.).

MALE.—(Brachypterous to macropterous) length of forewings, 0.3–1.7; width of head, 0.35–0.5; length of antennae, 1.0–1.7.

Terminalia: Fig. 8. Sense tubercles brown; paraprocts pale excepting for ventral brown area antero-mesally of sense tubercles; suranal plate produced into a small median, postero-ventrally-directed hook;

parameres fused basally, arms projecting laterally almost T-shaped; claspers mesally touching, posteriorly-directed, pointed processes about as long as anterior-posterior length of hypandrium; basal sclerites of claspers fused to hypandrium, the whole being broad with concave posterior margin.

FEMALE.—(Subapterous to macropterous) length of forewings, 0.1–1.9; width of head, 0.4–0.45; length of antennae, 0.9–1.4.

Terminalia: Fig. 36. Sense tubercles brown; paraprocts lighter brown; gonapophyses conspicuous brown mesally-directed, bluntly rounded flaps; subgenital plate broad, brown, emarginate anteriorly; ventral interior plate and dorsal interior plate transparent.

Types, Disposition unknown to me.

Records.—ARKANSAS: Washington Co., Aug. 19, 1942 (light trap) M. W. Sanderson ♀. CONNECTICUT: Mt. Carmel, Aug. 2–Oct. 14, 1941–'44 from corn and dried grass taken by K. M. and A. H. Sommerman 88 ♂, 68 ♀. ILLINOIS: Algonquin, Anna, Belvidere, Chicago, Champaign, Dongola, Elizabeth, Farmington, Glen Ellyn, Gorham, Hillsboro, Illiopolis, Johnson City, Lake Forest, Litchfield, Livingston Co., Marissa, Metropolis, Millshoals, Morris, Mt. Carmel, Palisades State Park, Pembroke, Shepherd, St. Anne, St. Jacob, Urbana, Ware, Watson, White Heath and White Pines State Park taken from dry organic material in dwellings and out-of-doors the year around. INDIANA: Fort Harrison, Aug. 12, 1942 (on windows) R. Traub 7 ♂, 10 ♀; Knox Co., July 20, 1938 (swept from peach) W. F. Turner ♂, ♀. IOWA: Ames, Aug. 29, 1924 H. L. Sweetman ♀; Cherokee, Sept. 22, 1940 (in fermenting barley) R. T. Cotton ♂♂; ♀♀. KANSAS: Meade Co., Sept. 13, 1944 R. H. Beamer ♂, ♀; Douglas Co., Oct. 22, 1944 (freshly painted house) R. H. Beamer 5 ♂, ♀; Onaga, Oct. 16, 1929 (on window) Crevecoeur 2 ♂, 2 ♀; Manhattan, May 19, 1929 R. H. Painter 2 ♀; Blair, June 24, 1937 P. G. Lamers ♂. KENTUCKY: Lexington, Sept. 14, 1927 (infesting dwelling) Mrs. Rogers 2 ♂, 4 ♀. MARYLAND: Washington, D. C., July 25, 1906 W. L. McAtee ♂, 2 ♀. MICHIGAN: East Lansing, June 2, 1941 C. Sabrosky ♂, ♀; East Lansing, Aug. 18, 1942 (walls of new house) C. Sabrosky 5 ♂, 3 ♀; Midland Co., June 21, 1945 R. R. Dreisbach ♀. MINNESOTA: St. Paul, 1941 (storage bin of corn) 2 ♂; Thief River Falls, Aug. 18, 1932 H. H. Shepard ♂, 4 ♀. MISSOURI: Columbia, Aug. 14, 1940 (in weather cabinet) P. C. Stone 8 ♂, 5 ♀; Columbia, Aug. 15, 1940 (ant carrying psocid) P. C. Stone ♀; Macon, June 8, 1941 H. Dybas 2 ♂; Scott Co., Sept. 24, 1936 (on peach foliage) W. F. Turner ♂; 7 mi. E. of Carrolton, Hannibal, 2 mi. S. of Jacksonville, Keytesville, Norborne and Richmond taken from corn in the field between October 15 and 22, 1940 by T. F. Winburn. NEW HAMPSHIRE: Mt. Washington, July 9, 1933 (Alt. 4,000) C. P. Alexander 2 ♂. NEW MEXICO: Las Vegas, May 8 H. S. Barber ♀. NEW YORK: Moravia, Oct. 11, 1922 C. R. Crosby ♂, ♀; Moravia, Sept. 3, 1922 (in house) H. McLean ♂, 2 ♀; Aurora, Sept. 30–Oct. 20, 1945 (dried leaves and dried corn) K. Sommerman 13 ♂, 28 ♀. NORTH DAKOTA: Wahpeton, Oct. 8, 1941 (wheat and barley) Hoel 20 ♂, 10 ♀; Walcott, Sept. 29, 1941 (barley granary) H. G. Grott 66 ♂, 58 ♀; Valley City, Oct. 2, 1941 (granary) C. Metcalf 114 ♂, 103 ♀; Langdon, Oct. 8, 1940 H. Stelford 2 ♂, 10 ♀. PENNSYLVANIA: State College, Sept. 15, 1941,

S. W. Frost 137 ♂, 159 ♀; Arendtsville, Nov. 2, 1922 S. W. Frost 3 ♂, 5 ♀. SOUTH DAKOTA: Meckling, Sept. 28, 1940 (barley) ♂, ♀; Fandreau, Oct. 8, 1940 (oats) ♂, 6 ♀. TEXAS: Dallas, April 15, 1908 F. C. Bishop ♂, ♀. UTAH: Provo, Aug. 23, 1938 (on peach) Christenson et al ♂. VIRGINIA: Falls Church, Sept. 12 N. Banks 3 ♀. WASHINGTON: Wenatchee, Sept. 7, 1938 (cherry foliage) Christenson et al ♂. BRITISH COLUMBIA: Kaslo, June 25 R. P. Currie ♀. SASKATCHEWAN: Saskatoon, Aug. 31, 1938 (grass) K. M. King ♀.

Lachesilla penta new species

This is a small tan species superficially resembling *forcepeta* from which it may be easily distinguished by the terminalia.

The only specimens available for study were dried material that had been relaxed and cleared *in toto* in KOH; so the intensity of color is not available.

MALE.—Length of wings, 1.8; width of head, 0.5.

Head: Light tan with usual dotted areas on vertex and lineations on clypeus.

Thorax: Concolorous with head, with color more intense on dorsum.

Abdomen: Terminalia, fig. 41, light tan; suranal plate bilobed with the tips of the lobes thickened forming ventrally curved knobs; paraprocts bearing mesally-directed prongs; claspers curved, posteriorly flattened blades abruptly narrowed at tip; parameres pale, fused forming a central shaft; hypandrium broad and pale, posteriorly drawn out into an acute mesal point.

FEMALE.—Length of forewings, 1.9; width of head, 0.6.

As near as can be determined the color pattern of the female is similar to that of the male.

Terminalia: Fig. 38. Pale, gonapophyses large, postero-mesally-directed flaps, in ventral view appearing much wider distally than basally; subgenital plate pale, broad and narrowed posteriorly, the distal part abruptly sunken; ventral internal plate broad with lateral limits more heavily pigmented; dorsal interior plate transparent.

Holotype ♂, Brownsville, Texas, May 2, 1904 H. S. Barber, USNM. *Allotype* ♀, same data as for holotype.

Lachesilla punctata (Banks)

Elipsocus punctatus Banks (1905, p. 1). ♂.
Lachesilla punctata Chapman (1930, p. 357). ♂, ♀.

This species superficially resembles ***nubilis*** or ***dona***. For a complete description of color characters see Chapman, (l. c.).

MALE.—Length of forewings, 3.0–3.4; width of head, 0.6–0.6; length of antennae, 1.7–1.9.

Terminalia: Fig. 15. Sense tubercles brown; paraprocts brown with posteriorly-directed, dark, sclerotized prongs; suranal plate pale, produced into a stout median posteriorly-directed hook, dark and sclerotized at tip; parameres fused at base, forming a long slender central shaft; arms branched again, the inner branches expanded distally into wide plates that form inner groove of groove clasp, apically the outer arm presses

against clasper too; claspers brown and heavily sclerotized, long slender processes that cross apically; hypandrium a small, narrow brown plate, basally between claspers.

FEMALE.—Length of forewings, 2.3–2.4; width of head, 0.6–0.6; length of antennae, 1.5–1.6.

Terminalia: Fig. 30. Sense tubercles brown; paraprocts pale; gonapophyses small, pale, postero-mesally-directed flaps exposed beyond subgenital plate; subgenital plate brown, with two truncate, posterolaterally projecting corners, with a median flap (part of ventral interior plate?) between them; ventral interior plate pale with deep median notch posteriorly; dorsal interior plate pale brown.

Holotype ♂, San Mateo Co., California, Baker MCZ.

Records.—ARIZONA: Sedona, Dec. 13, 1929 (peach foliage) L. D. Christenson ♂. CALIFORNIA: East Oakland, Feb. 22, 1936 P. W. McKinstry 2 ♀; Monterey, July 22, 1935 R. H. Beamer ♂; Albany, March 1, 1936 P. W. McKinstry 6 ♂, 5 ♀; Berkeley, Nov. 16, 1914 ♂; Berkeley, Oct. 14, 1915 E. O. Essig ♂. NEW MEXICO: Espanola, Nov. 4, 1938 (on clover) Christenson et al ♂.

Lachesilla rena new species

This is a small light brown spotted-winged species closely related to *pallida*, from which it differs by being macropterous in both sexes, having claspers of male not crossed, parameres fused, and having subgenital plate of female pigmented only as lateral strips, and posterior margin of subgenital plate narrowed.

MALE.—Length of forewings, 1.5–1.7; width of head, 0.4–0.45; length of antennae, 1.3–1.5.

Head: Pale, usual spotted areas of vertex small, light brown; so-called arms of epicranial suture distinct to antennal fossae; front light brown; ocelli pale; ocellar interval pale; twelve distinct brown mesally-directed bands on clypeus, lateral ones darker; genae clouded; antennal fossae bordered with brown; labrum and labial palps light brown; antennae pale proximally, brown distally.

Thorax: Dorsum pale, two brown areas on anterior part of middle lobe of mesothoracic scutum; lateral lobes pale brown; sutures pale; pleura light brown, sutures dark, with a very faint fuscous lateral stripe just above the coxae; legs light brown. Forewings subhyaline with distinct brown clouded areas at distal ends of veins, an interrupted brown band from end of Cu_2 to base of pterostigma, likwise from cell Cu_{1a} to tip of pterostigma; veins light brown; pterostigma opaque; hindwing hyaline, clouded at ends of veins; spot at end of cell Cu_2.

Abdomen: Pale, with indication laterally of fuscous rings; terminalia, fig. 9, light brown. Sense tubercles and paraprocts light brown; long, stout, dark, sclerotized, posteriorly-directed prongs mesally on paraprocts; suranal plate rounded and produced dorsally into a long, slender, anteriorly-directed process; parameres fused basally about two-thirds of their length; claspers short, posteriorly-directed, almost touching; hypandrium fused to basal sclerites of claspers.

FEMALE.—Length of forewings, 1.6–1.7; width of head, 0.4–0.45; length of antennae, 0.9–1.1.

The female is similar to the male excepting that the clouded areas on the forewing are so confined to the veins that there is no suggestion of bands across the wing; abdominal rings more conspicuous.

Terminalia: Fig. 37. Sense tubercles brown; paraprocts pale; gonapophyses short, enlarged basally and tapering to blunt point, light brown basally and laterally; subgenital plate narrowed posteriorly, projecting between claspers, posterior margin with median cleft, apparently weakened region at end of lateral pigmentation because the whole narrow tip can be bent forward like a flap, flap pale brown, dark at notch; ventral interior plate with two median pigmented bands that fuse posteriorly; dorsal interior plate with a pale transverse band between claspers.

Holotype ♂, Phoenix, Arizona, July 9, 1937 (cover sweepings in orchard) Christenson and Jones, USNM. *Allotype* ♀, same data as for holotype. *Paratypes.*—ARIZONA: Same data as for holotype, 6 ♂ (4 ♂, USNM, 2 ♂, KMS); Glendale, Dec. 16, 1939 (on grass) L. D. Christenson, 9 ♂, USNM; Phoenix, July 9, 1937 (from peach) Christenson and Jones, ♀, USNM; Mesa, May 28, 1938 (cover sweepings) Christenson et al, ♂, ♀, INHS; Phoenix, Sept. 14, 1937 (on foliage and cover) Christenson and Claney, ♂, ♀, KMS. CALIFORNIA: Hemet, Oct. 26, 1938 (in soil) Christenson et al, ♂, USNM; Hemet, July 29, 1940 (ex cover in orchard) Christenson and Jones, ♂, USNM. TEXAS: Brownwood, L. S. Jones, ♂, USNM.

Lachesilla riegeli new species

This is a medium-size tan species superficially resembling *anna* from which it may be easily distinguished by the two pairs of so-called claspers, stout shaft of parameres and posteriorly-directed prongs of paraprocts in the male.

MALE.—Length of forewings, 1.9; width of head, 0.5; length of antennae, 1.5.

Head: Pale, usual dotted areas on vertex light brown; brown stripe from anterior end of epicranial suture to antennal fossae, another from front to outer posterior margins of lateral ocelli; front brown; ocelli white; ocellar interval light brown; twelve pronounced, brown, mesally-directed bands on clypeus; brown streak from dorsal and ventral margin of antennal fossae posteriorly to eye; genae clouded; maxillary palps pale excepting for last segment which is brown, antennae brown.

Thorax: Dorsum brown, pale at sutures; two darker areas anteriorly on lobe of mesothoracic scutum; pleura light brown, sutures dark, a faint fuscous streak laterally just above the coxae; legs pale, tarsi darkest.

Abdomen: Pale, ringed with fuscous stripes; terminalia, fig. 5, brown. Sense tubercles brown; paraprocts lighter with prominent tan, pointed, posteriorly-directed prongs mesally; suranal plate pale, bilobed, with two yellow-brown, postero-dorsally-directed median hooks (almost fused); parameres fused and expanded basally, stout and dark. (There is a question in my mind concerning the inner pair of so-called claspers. Might they be the external part of the parameres as in *corona* ?) Two pairs of so-called yellow-brown claspers present, the laterad pair having prominent bases with a tapering shaft, turned postero-laterally at

apex, mesad pair about one-half length of others, tapering with tips slightly turned laterally; a membranous area below claspers excepting where they are fused at a point to their basal sclerite laterally; hypandrium wide, brown.

Holotype ♂, Miami Beach, Florida, May 17, 1945 (at blue light) R. A. and G. T. Riegel, KMS.

This species is named after G. T. Riegel who has contributed as a gift several collections of Corrodentia.

Lachesilla rufa (Walsh)

P(socus) rufus Walsh (1863, p. 185).
Caecilius rufus Hagen (1866, p. 206).
Caecilius impacatus Aaron (1866, p. 14). ♂.
Pterodela rufa Enderlein (1906, p. 319).
Lachesilla rufa Chapman (1930, p. 358). ♂, ♀.

This is a large tan species with subhyaline wings. For a complete description of color characters see Chapman, (l. c.).

MALE.—Length of forewings, 2.7–3.2; width of head, 0.6–0.65; length of antennae, 2.0–2.5.

Terminalia: Fig. 13. Sense tubercles brown; paraprocts pale with posteriorly-directed, light brown, pointed prongs; suranal plate pale, rounded; parameres fused at base, central shaft short, posterior arms long, slender, almost colorless blades; claspers sickle-shaped, tips directed postero-laterally, fused basally to a dark brown sclerite; hypandrium brown, darker basally, with a brown concave sclerotized band along posterior margin.

FEMALE.—Length of forewings, 2.5–3.0; width of head, 0.6–0.7; length of antennae, 1.6–1.9.

Terminalia: Fig. 27. Sense tubercles brown; paraprocts pale brown; gonapophyses pale, darker at base; basal sclerite slightly darker; subgenital plate broad, brown laterally, pale mesally, with a colorless forked flap distally, which is opaque at its base; light brown ventral interior plate external, fused to posterior of subgenital plate; dorsal interior plate with two dark longitudinal internal ridges, brown laterally, with a broad band along posterior margin.

Holotype.—According to Chapman the type of *rufa* is non-existant.

Records.—CONNECTICUT: Mt. Carmel between July 25 and Nov. 4 taken from dried leaves K. M. and A. H. Sommerman 59 ♂, 89 ♀. GEORGIA: Ft. McPherson, Aug. 2–31, 1943 (light trap) H. Hoogstraal 3 ♂; Ft. McPherson, April 28, 1943 (light trap) ♂. ILLINOIS: Cairo, Eichorn, Giant City State Park, Nr. Mayview, Muncie, Shady Rest and Urbana, Aug. 6–Nov. 8 taken from dried leaves. MICHIGAN: Midland Co., Sept. 15, 1945 R. R. Dreisbach ♀; Roscommon Co., Oct. 27, 1945 R. R. Dreisbach ♀. NEW YORK: Syracuse, Sept. 8, 1933 F. Fletcher ♀; Aurora, Oct. 20, 1945 (dried leaves) K. Sommerman 7 ♂, 28 ♀; Rock City, Sept. 16, 1925 (beating dry leaves) 6 ♀; Ceres, Sept. 16, 1925 (beating dry leaves) ♂, ♀. NORTH CAROLINA: Nautahala Gap (Macon Co.) Oct. 16, 1926 Crosby and Bishop ♀. PENNSYLVANIA: State College, Sept. 15, 1941 S. W. Frost 2 ♀. TENNESSEE: Mt. Le Conte (Mill Creek, below falls) Oct. 10, 1926 Crosby and Bishop 2 ♂. VIRGINIA: Falls Church, Oct. 11 N. Banks ♀.

Lachesilla silvicola Chapman

Lachesilla silvicola Chapman (1930, p. 361). ♂, ♀.

This is a medium-size tan species resembling *arida*. For a complete description of color characters see Chapman, (l. c.).

MALE.—Length of forewings, 1.9–2.3; width of head, 0.5–0.55; length of antennae, 1.5–1.6.

Terminalia: Fig. 6. Sense tubercles brown; paraprocts brown, each bearing a stout posteriorly-directed, bluntly-rounded, mesal prong; suranal plate produced laterally into two light brown, crossed, asymmetrical, twisted hooks; parameres fused at base, distal arms broadly U-shaped; claspers fused to form a single posterior spear-head prong, asymmetrical and directed to the left; hypandrium triangular, fused laterally to basal sclerites of claspers.

FEMALE.—Length of forewings, 2.1–2.2; width of head, 0.6–0.65; length of antennae, 1.3–1.5.

Terminalia: Fig. 25. Sense tubercles brown, paraprocts pale brown; gonapophyses bluntly pointed, postero-mesally-directed, pale, tapering flaps; subgenital plate with a forked flap distally, flap narrower at base than distally and fork extending about one-fourth of length to point of attachment; ventral interior plate external, fused to subgenital plate (the region posterior of base of flap); ventral interior plate colorless.

Holotype ♂, Seattle, Washington, August 7, 1927 C. R. Crosby, PJC.

Records.—CALIFORNIA: Near Hollywood, Dec. 25, 1941 (sweeping grass and shrubs) Sommerman and Hasbrouck ♂; Hemet, Dec. 26, 1938 (in soil) Christenson et al ♂; Ontario, July 27, 1938 (cover grass) Christenson et al ♂; Yuba City, Sept. 19, 1938 (on peach) Christenson et al ♂. COLORADO: Midland, Aug. 8, 1943 (on Limber pine) J. A. and H. H. Ross 2 ♀; Cascade, Aug. 28, 1924 C. R. Crosby 3 ♀. OREGON: Portland, R. P. Currie 3 ♀; Corvallis, April 29, 1931 ♂. WASHINGTON: Longmire, Aug. 22, 1927 C. R. Crosby 2 ♀. WYOMING: Yellowstone National Park (Old Faithful) Aug. 27, 1927 C. R. Crosby ♀. BRITISH COLUMBIA: Kaslo, Jan., 1908 R. P. Currie ♂; University, Oct., 1928 G. J. Spencer 2 ♂.

Lachesilla telsa new species

This is a medium-size, light brown species, closely resembling *pacifica* from which it can be distinguished by cleft of ventral interior plate being posterior instead of anterior.

FEMALE.—Length of forewings, 2.0; width of head, 0.5; length of antennae, 1.1.

Head: Pale, with usual dotted areas on vertex distinct and brown; front brown; ocelli pale with dark inner crescents; ocellar interval pale; clypeus with about twelve mesally-directed light brown bands that almost merge; genae pale, clouded in the middle; antennae, palps and labrum light brown.

Thorax: Dorsum brown paling at sutures; pleura and legs light brown. Wings subhyaline; veins light brown; pterostigma subopaque.

Abdomen: Pale with fuscous markings laterally; terminalia, fig. 24, brown. Sense tubercles light brown on dorsal corner of paraprocts; ventral mesal region of paraprocts swollen and light brown; gonapo-

physes curved mesally, light brown; subgenital plate brown, overlapping bases of gonapophyses; sclerotized portion of ventral interior plate brown, near posterior margin of subgenital plate, with a median triangular non-pigmented area posteriorly; dorsal interior plate transparent.

Holotype ♀, near Hollywood, California, Topanga Canyon, Dec. 25, 1941 (sweeping grass and shrubs) Sommerman and Hasbrouck, KMS. *Paratype* ♀, Vancouver, B. C., University of B. C., October, 1928 G. J. Spencer, CNM.

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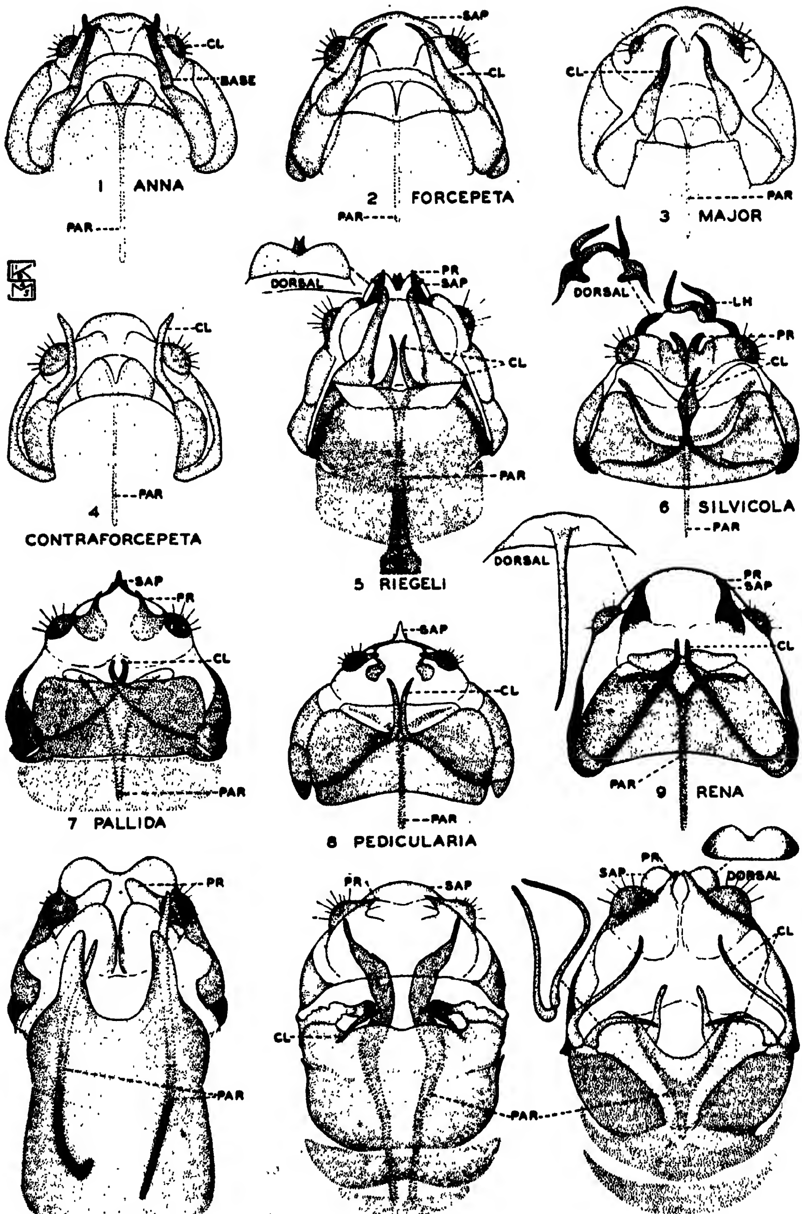
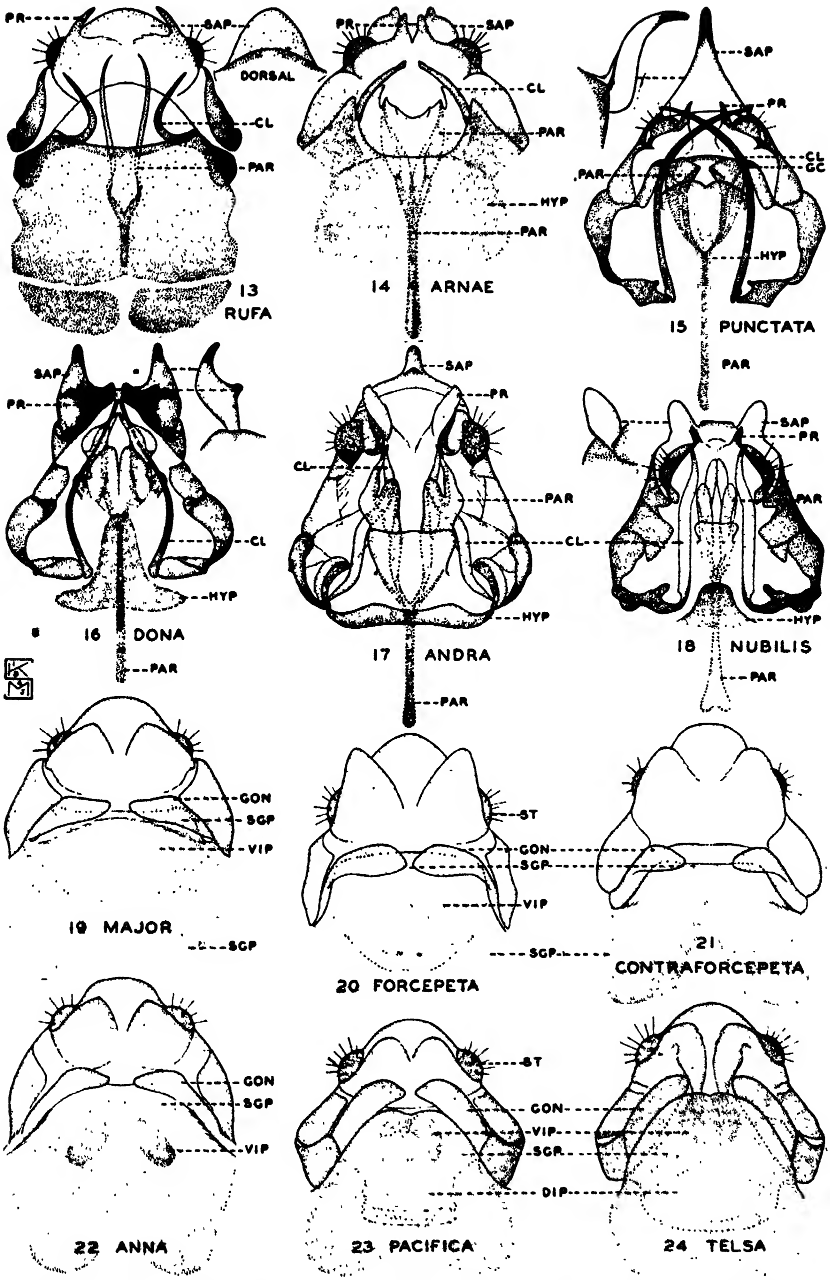
ABBREVIATIONS ON PLATES

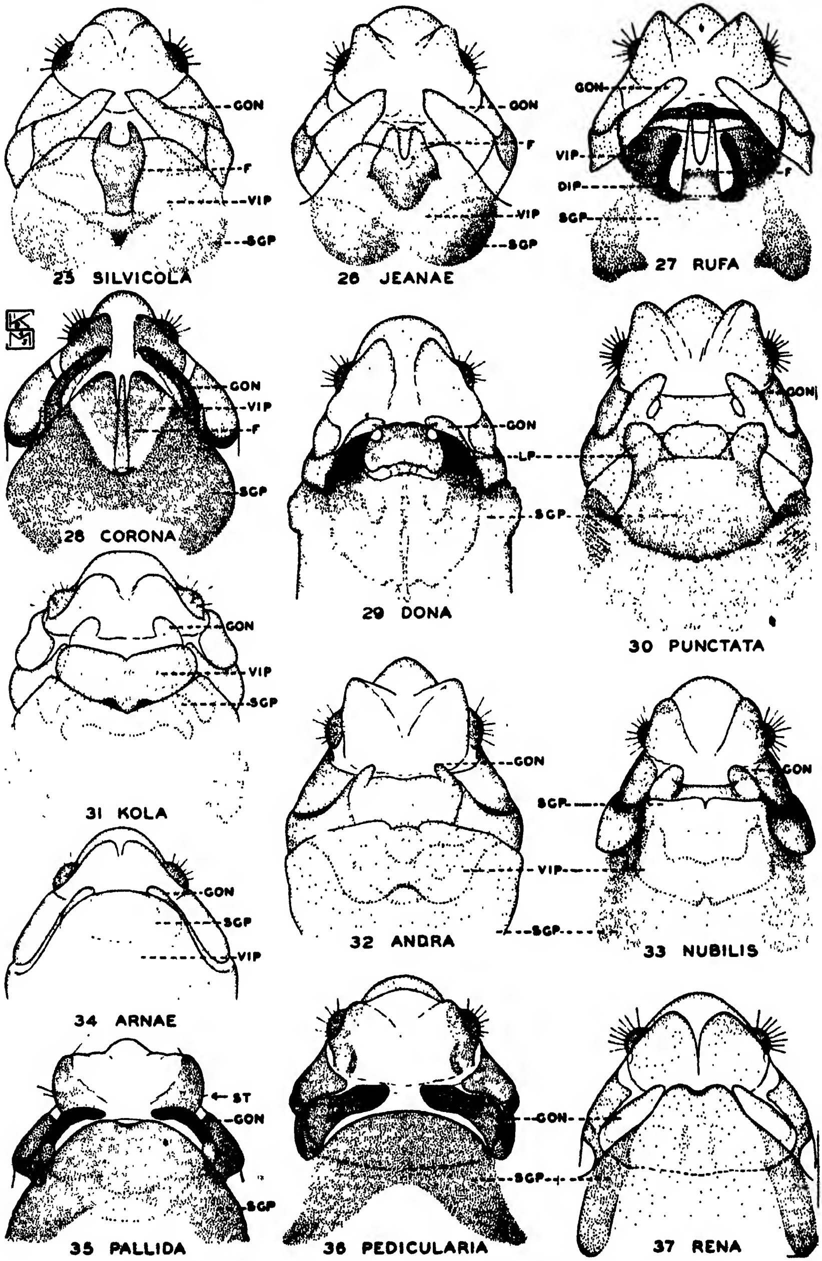
CL—claspers ♂.
DIP—dorsal interior plate ♀.
F—flap ♀.
GC—groove clasp ♂.
GON—gonapophyses ♀.
HYP—hypandrium ♂.
LH—lateral hooks ♂.
LP—lateral projections ♀.
PAR—parameres ♂.
PR—prongs ♂.
SAP—suranal plate ♂ and ♀.
SGP—subgenital plate ♀.
ST—sense tubercles ♂ and ♀.
VIP—ventral interior plate ♀.



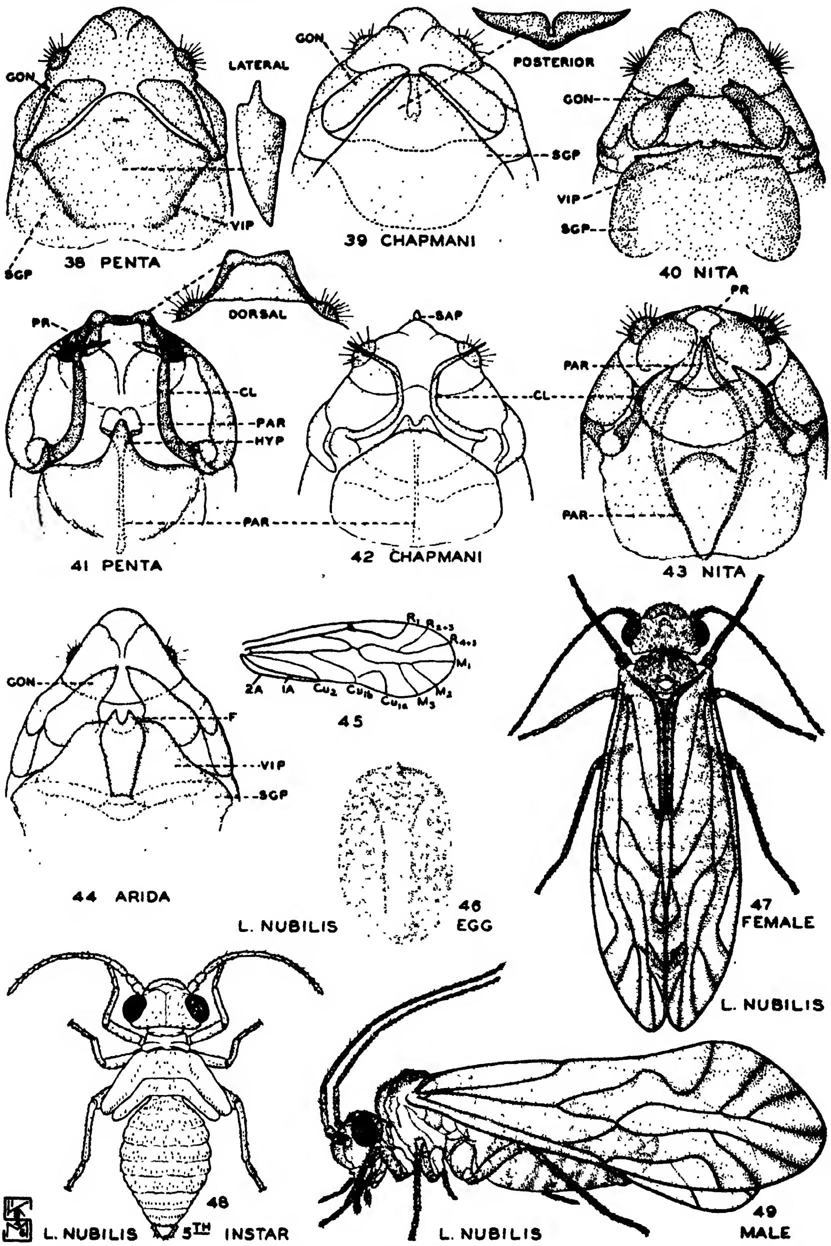
FIGS. 1–12. Male terminalia, postero-ventral view, excepting inserts.



FIGS. 13–18. Male terminalia, postero-ventral view, excepting inserts.
FIGS. 19–24. Female terminalia, postero-ventral view.



FIGS. 25–37. Female terminalia, postero-ventral view.



FIGS 38–40, 44. Female terminalia, postero-ventral view. FIGS. 41–43. Male terminalia, postero-ventral view, excepting inserts. FIG. 45. Right forewing showing venation and terminology. FIG. 46. Egg, dorsal view (not to scale of others). FIG. 47. Adult female, dorsal view. FIG. 48. Fifth instar nymph, dorsal view. FIG. 49. Adult male, lateral view.

EPIGOMPHUS SUBQUADRICES, A NEW DRAGONFLY (ODONATA: GOMPHIDAE) EROM PANAMA, WITH NOTES ON E. QUADRICES AND EUGOMPHUS N. SUBGEN.

CLARENCE HAMILTON KENNEDY,
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Columbus, Ohio

The species described as new came to the writer in a small collection of dragonflies from Panama mostly collected by Dr. Dale Jenkins, tropical botanist and rubber expert. In the collection was one envelope labeled "Cerro Campana, 2000 ft., Panama Prov., R. P., VIII–10–41, Graham Fairchild." The specimen was completely eaten out by ants or other tropical scavangers and fell to pieces on relaxation. Nothing remains but the hollow exoskeleton.

On examination, the specimen, a male, was found to be closely related to *Epigomphus subsimilis* Calvert, of Costa Rica, and to *quadrices* Calvert, of Guatemala and Panama. We apply the rather awkward compound *subquadrices* to the new species in recognition of this relationship.

Epigomphus subquadrices, n. sp.

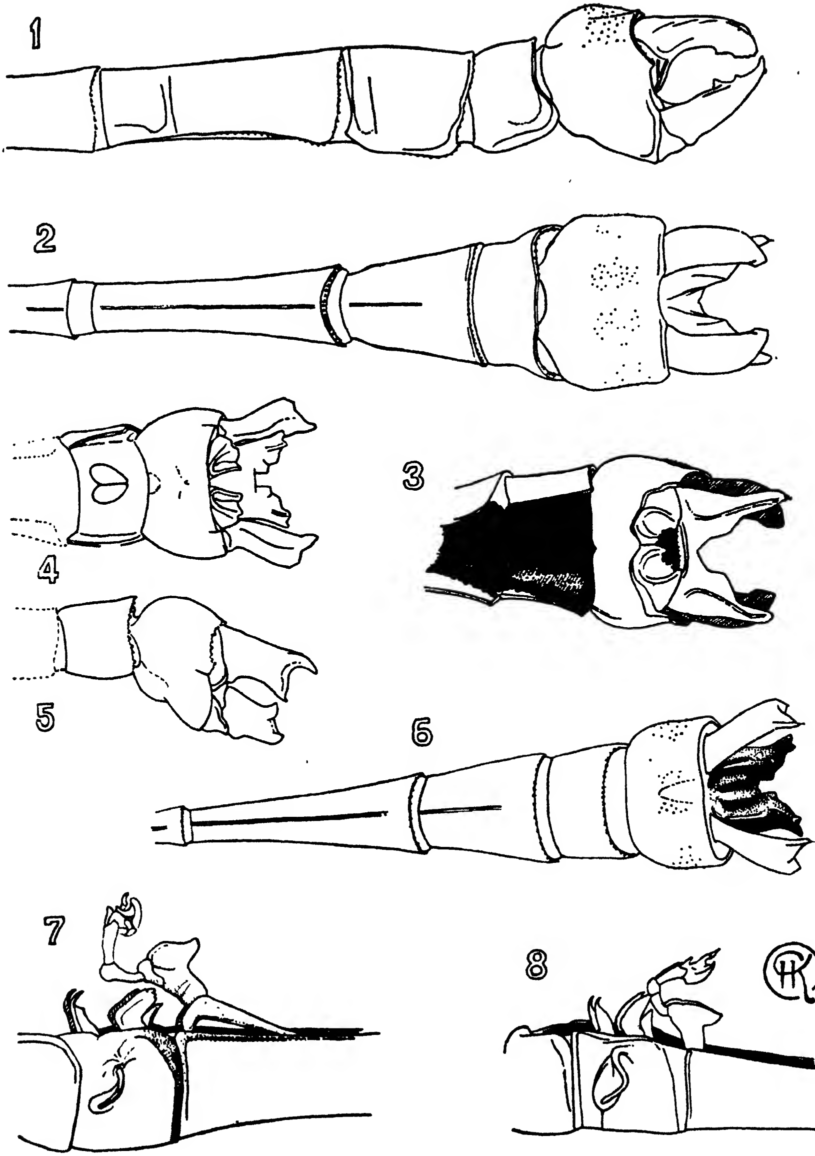
(Figs. 1–3, 7, and 9–13)

Described and figured from the unique holotype in the Kennedy collection. Length of abdomen, including appendages, male, 43 mm.; of hindwing, 36 mm.

Male holotype: Head.—Labrum uniformly dark (brown or black) with a nearly circular yellow spot in each upper outer angle (fig. 11); anteclypeus, postclypeus, frons, vertex and occiput dark (brown or black) except for a pair of oval gray-green spots, barely separated along median line, which cover the anterior two-thirds of the horizontal surface of the frons and whose anterior edges lap down over the upper fifth of the vertical frons surface (fig. 12). Antennae black with pale intersegmental rings. Bases of mandibles yellow but genae slightly darker (gray or pale greenish). Rear of head pale (fig. 10), except the black occipital edge, but with the upper half grayish-green to level of the foramen below which it is pale flavid with mouthparts nearly white.

Prothorax dark with posterior lobe black just in front of which is a cross-row of four pale dots. Proepisternum brownish; coxa pale (yellowish).

Synthorax.—A dark velvety brown, probably black in the living mature insect, the lower sides, venter and coxae pale grayish white (fig. 13). Mid-dorsal keel edged above with a hairline of pale. Each mesoepisternum black with a narrow crossbar below; a diagonal, narrow (width one-twelfth its length) vertical pale green stripe whose lower end is two-fifths of the distance from the middorsal keel to the humeral suture and a triangular dot with rounded angles in the upper posterior angle. Mesinfraepisternum pale but darker above. Side black with a narrow remote posthumeral stripe slightly wider than that on the



FIGS. 1–3 and 7. *Epigomphus subquadrices* n. sp., male.
FIGS. 4–6 and 8. *Epigomphus quadrices* Calv., male, Panama.

episternum and which widens below the alar ridge into a triangle. Lowest fifth of the mesepimeron a sharply defined pale spot. Metepisternum with a pale stripe detached from the second lateral suture. This is broad below enclosing the spiracle and confluent with the pale yellow of the metinfraepisternum which carries a vague cloudy spot. Metepimeron pale with a narrow black stripe along its anterior edge. Legs black with under surfaces of femora shading into pale (greenish). Stigmas of wings dark brown.

Abdomen.—The apical rings in all segments, except on lower side of seg. 1, black. Segs. 1–3 black above with lower two-thirds of sides pale, that on seg. 2 including the pale auricle. Segs. 4–6 as in 1–3, except that all of each segment from the vertical lateral keel to apex is black. Seg. 7 pale (yellow) with apical third black. Segs. 8–10 dark; 8 black, 9 and 10 may be dark reddish brown in life as are the appendages in present state of preservation.

Structural Characters.—The appendages are shown in figs. 1–3. The specimen is so fragile that the appendages could not be spread enough to give a dorsal view of the inferior appendage.

The ventral view of the inferior appendage with its broad, deep median notch with stepped mesal edges of the two prongs distinguishes the species from all other described forms. Added to this, the dorsal surface of the inferior has three nearly equidistant teeth beyond its middle. The superiors are of the heavily tipped type. Fig. 7 of seg. 2 shows that the anterior hamules appear to have had their tips injured (by ants). Fig. 7 shows the decayed sternite of abd. seg. 3 torn out of position. The structure of the penis tip is too badly decayed to figure accurately. The minute apical prong is erectile to twice the length in fig. 7. The auricle on abd. seg. 2 is small and in edge view as shown is crescent-shaped.

Female unknown.

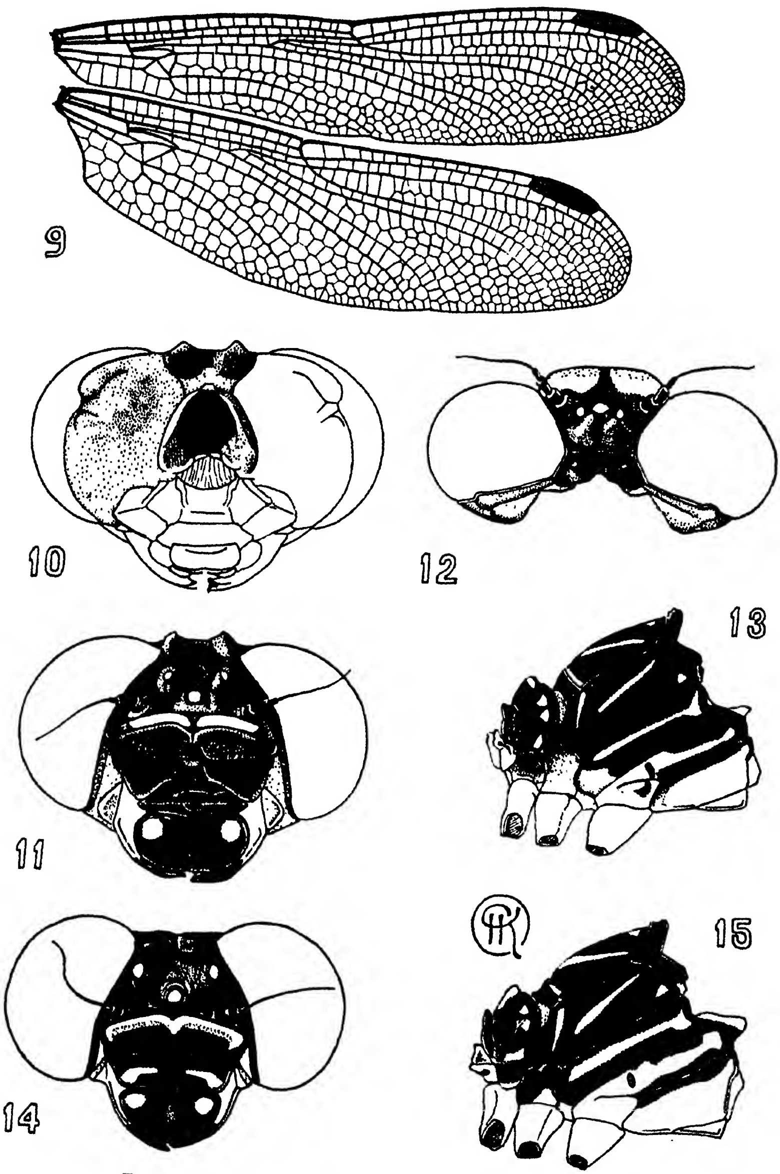
The relationship of subquadrices as judged by male appendages are with *subsimilis* Calvert, 1920, p. 325, pl. XIII, figs. 1–7, and *quadrices* Calvert, (1903), 1920, p 325, pl. XIII, figs. 8–10. Of the two it is nearer *quadrices* from which it differs in having inferior appendages slightly longer than the superiors. *Subquadrices* differs from both related species in that its inferiors have a simple apex; in the other two a notched apex. See *subquadrices*, figs. 1–3, and *quadrices*, figs. 4–6.

In a letter Professor Calvert, on studying tracings of the author's figures, suggested that *subquadrices* is related to *subobtusus* Selys and *tumifactus* Calv. The author considers these the next closest pair of species to the group, *quadrices, subsimilis* and *subquadrices*. The writer's opinion is based on the more elaborate configuration of the inferior appendage of the males of *quadrices*, *subsimilis* and *subquadrices*. On this basis the inferior of *subobtusus* is simple as in *crepidus* while Calvert's fig. 20 (1920) of a dorsal view of the inferior of *tumefactus* does not show as highly developed configuration as that shown in his fig. 8 (1920) for the inferior of *quadrices*. The five species, however, are close and can be variously related on head and color-pattern colors.

Epigomphus quadrices Calv.

(Figs. 4–6, 8 and 14, 15)

We add to the description of *subquadrices*, n. sp., figures of *quadrices*



FIGS. 9–13. *Epigomphus subquadrices* n. sp., male.
FIGS. 14 and 15. *Epigomphus quadrices* Calv., male, Panama.

Calv. because it is one of the two most closely related species of which we have a short series from Panama. The other close species, *subsimilis* Calv., we have studied only from Calvert's good description but limited figures. We feel this is a proper place for the addition of more figures on Neotropical dragonflies. We need them. See *antea* for further remarks on the relationships of *quadrices*.

Eugomphus, new subgenus

SUBGENERIC GROUPS AND DISTRIBUTION

The genus *Epigomphus* appears to fall into two natural groups morphologically and geographically:

I. *Subgenus Epigomphus:* genotype and subgenotype *paludosus* Selys, 1854, female, the only sex known, "Brazil." This is the typical subgenus with the female *paludosus* the type by the Rules of Nomenclature. This will stand, no matter what the male will be found to be. We associate with it three Andean species: *obtusus* Selys, 1869; Bogota, Col., to eastern Ecuador (Kennedy coll.), Peru and Matto Grosso, Brazil. This is the most widely spread species. Included are *llama* Calv., 1903, Peru and Bolivia; *hylaeus* Ris, 1916, Matto Grosso, Brazil, to Rio Zamora, S. W. Ecuador (Kennedy coll.).

In the three males the group is distinguished by the pointed and narrowly tipped anal superior appendages. See Kennedy, 1936, p. 129, *obtusus*, Ris, 1916, *hylaeus* and *llama*.

II. Subgenus nov. *Eugomphus:* subgenotype, *quadrices* Calv., 1903, Mex. to Panama. Associated with it are: *subobtusus* Selys, 1878, Costa Rica, Guatemala; *tumefactus* Calv., 1903, C. R.; *camelas* Calv., 1905, C. R.; *armatus* Ris, 1916, C. R.; *subsimilis* Calv., 1920, C. R.; *verticornis* Calv., 1920, C. R.; *crepidus* K., 1936, Mex.; and *subquadrices* K., 1946, Panama.

The males of the species of Eugomphus are distinguished by superior anal appendages which are broadly truncate in some or are broadly thickened apically in others.

Eugomphus is northern in distribution, Mexico to Panama (and perhaps into northwest Colombia), while the species of the subgen. Epigomphus are southern, Colombia to Ecuador, Peru and Matto Grosso.

The species *crepidus* in the widely forked and simple appendages of the male appears to be nearest (most primitive) to the generalized species of Gomphus of the Holarctic Realm. It occurs in Nayarit in Sinaloa, Mex., on a possible route from eastern Asia, if it was not differentiated from Gomphus or related stock in North America.

LITERATURE CONSULTED

In addition to that listed in "*Epigomphus crepidus*, a new dragonfly from Nayarit, Mexico, with notes on the genus," Ann. Ent. Soc. Amer., 29: 126–135, 1936, Kennedy, we list:

Calvert, P. P. 1921. Odonata (on copulation in *Epigomphus*). Ent. News, 32: 96.

Needham, J. G. 1940. Studies on Neotropical Gomphine Dragonflies (Odonata). Trans. Amer. Ent. Soc., 65: 363–394. IV. Venational key to genera of neotropical gomphinae, pp. 387–389. (Key to South American genera.)

Kennedy, C. H. 1925. New genera of Megapodagrioninae, with notes on the subfamily. Bull. Mus. Comp. Zool., 67: 291–311, 1 pl. (Reference to Oriental affinities of Neotropical genera.)

A STUDY OF THE EGGS OF THE PENTATOMIDAE (Hemiptera)[1]

CHARLES O. ESSELBAUGH

For a number of years the writer has been interested in the Pentatomidae, more recently from the standpoint of their bionomics. Further investigation has, as usual, served to emphasize how little we really know about this relatively uneconomic group. This seems to be particularly true concerning the eggs, hence the present effort on the part of the writer to make available such data as he has been able to assemble up to the present. The greater part of the material in this paper constitutes a portion of the writer's thesis presented for the doctorate.

Kirkaldy (1907) is authority for a statement to the effect that the maximum ornateness of eggs is to be found in the Pentatomidae and Reduviidae. Also, it would seem that a close study of the eggs of many a group would be of much importance, if not an absolute necessity, in order to reach any basically sound conclusions regarding the phylogeny of that group, an idea previously expressed by both Reuter (1910) and Schumacher (1917), but which to date does not seem to be much in vogue.

The writer has no illusions as to the state of completion of the present paper. It is strictly preliminary. There are still many genera and even some subfamilies not represented. There are also some intermediate forms, such as *Stiretrus* and *Podops*, whose kinships are uncertain, which need to be studied.

In view of the reputed close relationship between this family and the Scutelleridae, it had been hoped that a comparison of the eggs of the latter could be included in this paper but none have yet been available to the writer for study. Harris and Andre (1934) have figured and briefly described the egg of the scutellerid, *Acantholoma denticulata* Stål. A glance at the figure immediately suggests the difficulty of distinguishing it from the egg of a pentatomid. A ring of 15 or 16 chorionic processes is shown and likewise a hexagonally reticulate chorion is indicated in the text. The egg is more spherical in form than those of most, but not all, Pentatomidae. The indicated color, robin's-egg blue, is also a unique one but is far from likely to be important. The size is well within the limits for pentatomid eggs.

PREVIOUS CONTRIBUTIONS

Perhaps the first significant contribution was that of Korschelt (1887), who discussed the formation of the chorion and its accessories. Heymons (1906) has discussed the egg-burster, having studied it in the European species *Palomena dissimilis* F. A more recent work by Miller (1934) discusses the egg-burster and its variations, illustrated by

[1]Contribution No. 268 of the Department of Entomology, University of Illinois. Acknowledgments for much help and encouragement are due Drs. C. L. Metcalf, W. P. Hayes and W. V. Balduf.

23 figures. Schumacher (1917) has reviewed the literature on the egg-burster and checked its presence in the eggs of a long list of Pentatomidae and Scutelleridae. The latter author points out the interesting fact that this structure was first observed by Harris (1766) in the egg of *Palomena prasina* L., but the egg was mistaken for that of a coccinellid.

One of the principal works of a general nature is that of Heidemann (1911). He has reviewed the works of Leuckart, Korschelt, Heymons and Gross. The work, as it concerns the Pentatomidae at least, is, on the whole, very informative and contains four good illustrations of pentatomid eggs, three of which are unfortunately erroneously determined. In the interest of accuracy it would seem well to make it a matter of record that fig. 1 of his Plate IX is actually *Euschistus* sp. rather than *Thyanta custator;* fig. 2 is in reality *Podisus* sp. instead of *Cosmopepla carnifex* and fig. 4 is *Acrosternum* sp. instead of *Euschistus*. Fig. 3 is *Brochymena* as labelled. The brief general description given for the egg of *Podisus* is correct except for the fact that the length of the chorionic processes has been considerably exaggerated, but his statement concerning the egg of *Cosmopepla* is completely erroneous and really pertains to *Podisus*, which he says it greatly resembles. One of his conclusions concerning phylogeny is of interest. He considers the presence of the egg-burster in the eggs of the Coreidae to indicate a close relationship to the Pentatomidae.

Couturier (1938) has made a very careful anatomical and physiological study of the eggs of *Podisus maculiventris* Say, an American species then being introduced into France to combat the Colorado potato beetle. The eggs of a number of foreign Pentatomidae have been described by Butler (1917, 1922, 1923), Michalk (1935), MacGill (1942) and others.

GENERAL CHARACTERISTICS

Egg Mass.—The eggs of this family are apparently never deposited singly under normal conditions although an unfertilized female, or one which has virtually completed her oviposition, may do so occasionally. The ovipositing female places the eggs on end with more or less care, depending upon the species and apparently to some extent upon the regularity of the substratum. The end upon which the egg stands is the posterior pole of the embryo which is to develop. The eggs are kept in position by an adhesive material, secreted by the female, which fastens them to the substratum and to each other. Strangely enough this material is never placed upon the tops of the eggs, where it might interfere with the hatching process. Bonnemaison (1946) states that this secretion is also the medium for transmission of symbiotic bacteria from the parent to the offspring, the latter taking them up at the time of hatching.

It seems to be agreed by the various observers that the tendency in this group is for the female, when ovipositing upon foliage, to utilize the under side, but two of the predaceous species studied, *Podisus maculiventris* Say and *Perillus bioculatus* Fabr., seem to prefer the more brightly lighted surface, which ever that may be. Stems and fruits, and even flower parts, are frequently used as substrata for oviposition and caged individuals frequently oviposit on the sides and top of the cage.

An exceedingly hairy surface, such as that of ordinary mullein, *Verbascum thapsus* L., is seldom oviposited upon.

Much has been made of the startling regularity of the rows in which the eggs are placed by the female. However, when one considers the manner in which the oviposition is performed, it at once becomes apparent that the rows could scarcely be otherwise than straight, provided the eggs are of uniform diameter, which is nearly always the case. After placing the first two eggs contiguous to each other, the third egg is simply placed in the angle formed by the peripheries of the first two and forced in until it is in contact with both of them. The fourth egg is placed in a similar manner between the second and third. With only slight modification the mass can be formed of two rows or of more, but in any case all the rows are straight. Actually the egg masses of many species are composed of two rows, or sometimes with a partial third, while others typically place the eggs in four or more rows. In some species the form of the mass is adapted to the nature of the space available, being composed of two rows when placed on a small stem or on a fruit of linear form, but in several rows when placed on a leaf blade or other broad surface.

Egg.—The eggs themselves possess several characters which rather readily distinguish them from groups other than the Scutelleridae. The outstanding characteristic most commonly noted by casual observers is the shape of the egg. The eggs of the different species have been designated by various authors as barrel-shaped, cauldron-shaped, drum-shaped, cup-shaped, ovoid and ellipsoidal. These terms are more or less synonymous except the last two, which imply more curvature to the sides as well as the ends, a condition which exists in greater or less degree in about half the species whose eggs have been observed by the present writer. In the other half of the species the eggs greatly resemble a tiny keg, except that the ends are seldom entirely flat. In no case so far observed has the end upon which the egg rests been found to be flat, but this fact usually escapes notice, due to the adhesive in which it stands. The upper end of the egg is in many species decidedly flattened but, with the exception of *Solubea pugnax* Fabr. (fig. 15), is perceptibly convex. MacGill (1942) figures the egg of the European species, *Acanthosoma interstinctum* Linn., as distinctly pointed at the anterior end.

The remaining characters worthy of note have to do with unusual structures, viz., the operculum, egg-burster and chorionic processes, all of which seem to be almost universally present. Chorial spines are also present in some species. The chorion may or may not have other outstanding ornamentation, such as pits, ridges or color.

Operculum.—The operculum is a circular lid comprising essentially the entire upper end of the egg. Its function is to provide an adequate opening for the emergence of the hatching nymph. As the above terminology would seem to indicate, the operculum is actually a distinct unit, separated from the remainder of the chorion by a suture or seam which tends to open when the hatching nymph is forcing its way out. The suture may or may not be discernible before hatching and may even be non-functional, the chorion breaking to one side or the other of it. The initial rupture, however, caused by the egg-burster, seems

to be invariably along the suture but may not continue to follow it. Usually the operculum remains attached by a small arc of its circumference. The usual implication that the operculum is provided with a hinge at this point is probably without foundation in fact, the arc merely remaining intact for the same reason that the end of a tin can hinges when opened by the old-fashioned type of can-opener, viz., lack of tearing action at that point.

Egg-burster.—The egg burster seems to be universal in this family. According to Schumacher (1917) this device also occurs in the eggs of the Scutelleridae and another form of it occurs in the Coreoidea. The above author, and likewise Reuter (1910) considers this and the chorionic processes to be of much significance in phylogeny. The present writer has attempted to illustrate this interesting structure in the drawing of the egg of *Perillus bioculatus* Fabr. (fig. 18). It does not become evident until embryonic development is fairly well completed. At this time, if the chorion is transparent, the egg-burster can be seen as a fuscous or black crescent almost directly beneath the opercular suture, appearing at about the same time as the red eye-spots, which are also located nearly directly under the suture and usually diametrically opposite each other. Both the egg-burster and the eye-spots can be seen to move during the last day or so preceding the hatching of the egg.

It is interesting to note at this point two statements in published literature regarding the opening of the egg. Butler (1923) quotes Muir (without citation) to the effect that "in those species provided with an egg-opener, this instrument actually cuts through the chorion, and does not always cut it along the line of the so-called cap." C. V. Riley (1872), in writing of the egg of the harlequin cabbage bug, states the nymph opens the egg with its beak.

The operation of the egg-burster is quite simple and does not vary in its essentials in the species whose eggs have been examined by the writer. It does not cut. It is composed in part of a rigid material, usually referred to as chitin, and the remainder of three more or less membranous, triangular pieces, each attached on two sides to the rigid part mentioned above. Three rigid arms intersect at their ends to form a very blunt trihedral angle whose vertex is directed upward. The angles between the nearly horizontal arms and the upright, and that between the arms, are occupied by triangular pieces of much less rigid construction. This structure rests upon the dorsum of the unhatched nymph in much the same manner as a yoke used for carrying water pails is carried. The cross arms rest on the anterior margin of the pronotum and the upright extends down the middorsal line. The head of the nymph is deflexed to such an extent that the obtuse angle on the top is enabled to press upward against the extreme edge of the operculum, where it is applied with sufficient force to open the suture at that point. The thin triangular pieces referred to above probably serve to provide a greater amount of surface against which the soft body of the hatching nymph may exert force. The suture is torn open in both directions from the starting point by pulsations of the emerging nymph.

Chorionic processes.—The chorionic processes have been observed

and commented upon by many writers. So far as our knowledge goes, they are universally present on the eggs of Pentatomidae, but on the eggs of some species, like *Murgantia histrionica* Hahn, are so minute as to have escaped notice, or at any rate they never seem to have been mentioned in any of the many descriptions of the egg of this economically important species. In other species, such as members of the genus *Podisus*, they are sufficiently prominent to be visible to the unaided eye.

These processes are always arranged in a circle just outside, and usually below, the opercular suture. They are unarticulated continuations of the chorion. Their form and number vary within rather wide limits within the family but the variations in number within a given species, or even among the eggs of a given mass, is usually nearly as great as within the genus itself, thus precluding the use of this character for separating congeneric species. In the species investigated by the present writer the extremes in number of processes encountered in normal eggs extended all the way from as few as fifteen in *Podisus* to as many as seventy-two, or thereabouts, in *Solubea*. In the latter the processes are practically contiguous.

It seems there has been considerable difference of opinion among various writers concerning the function of these processes. Leuckart (1855) considered them to be a sort of micropyle apparatus, having an opening for the entrance of spermatozoa, but Julius Gross (1901) proposed that these served as an aeration device to substitute for an otherwise impermeable chorion. The latter view seems to be the one currently accepted. Whatever may be their function, it is certain that these appendages are hollow. This was finally demonstrated to the satisfaction of the present writer when some eggs which had just been removed from a vial of alcohol were placed on a watch glass for study under a dissecting microscope. The desk lamp, placed near the eggs, generated sufficient heat to build up some vapor pressure within the eggs, thus forcing fluid out through the lumen of a number of processes and causing it to collect in droplets on their apices. Microscopic examination had also seemed to indicate an opening within, but had been somewhat inconclusive.

In view of the fact that the chorionic processes are considered to perform the function of aeration, it was with considerable interest that the writer observed one egg mass of *Podisus maculiventris* Say in which four of the eggs were abnormal in that the number of chorionic processes was radically reduced. These four eggs had one, two, three and six processes respectively. They were closely watched to see whether the embryos would develop normally but no visible evidence of embryonic development took place. It so happened, however, that several adjoining eggs in the mass, although apparently normal, also failed to develop, so the failure could as well have been due to causes other than insufficient aeration.

Spines.—In addition to the chorionic processes just discussed, the chorion of many pentatomid eggs is also provided with other outgrowths, known in the literature as chorial spines. These differ from the processes in several respects, being of solid construction and pointed rather than knobbed at the apex. In addition to this they are usually

much shorter and, when present, usually occur on all parts of the egg. Although the spines usually cover the entire surface they are frequently much longer on the central portion of the operculum and on the upper half of the side walls.

In most of the spinous eggs so far studied the spines have been accompanied by a peculiar structure of the chorion, the latter seeming to be marked off by fracture-like lines, forming small, angular, closed figures. At each intersection of these fracture-like lines stands a spine. Upon microscopic examination the writer has found that in most species, but not all, this network is formed of a single line of close-set minute spines. Occasionally a few of these latter are also to be found within the cells formed by the network. For the purpose of distinguishing the two types of spines, the larger ones found at the intersections of the network will be designated as primary spines and the minute ones found along the sides and within the cells as secondary spines. In one species, *Menecles insertus* Say, only primary spines are to be found and no form of reticulation is to be seen.

Imms (1929) states that in most insects the chorion exhibits some form of external sculpture, being very commonly marked off with hexagonal areas which correspond with the overlying follicular cells which secrete it. There is no mention of spines in relation to this network. About the only possible explanation of the origin of the spines is that they are formed in interstices in the layer of follicular cells, but their uniformly tapered form would seem to contradict this.

The chorion has been described by Korschelt (1887), who states that "the smaller eggs have the texture of the outer surface granulated, while in the larger eggs it is very uneven, covered with polygonal cells, often spinous and tubercular." It is, however, the observation of the present writer that there is little if any relation between the size of the egg and type of sculpturing on the chorion.

In those eggs whose chorion is not spinous it may be smooth and shining or rough and without lustre. In some the chorion apparently has deep pits or punctures, others heavy ridges suggestive of a miniature mountain range. Still others seem to be covered with a vein-like network which may have minute spines coming up from it or may appear to be composed of tiny granules.

In the eggs of most species of Pentatomidae the chorion is transparent, permitting the observer to see the egg contents, but in a few there is sufficient pigment to render it opaque. According to Couturier (1938), in the eggs of *Podisus maculiventris*, the pigment is not contained in the chorion, but in a serous mantle which covers the entire egg, including the unusually long spines. In this species the color may vary from lustrous pearly to almost black, being influenced, according to the above author, by the food eaten or whether the oviposition took place in light or darkness. In this instance the serous mantle is closely draped over the long spines, and in drying forms a thin, membranous web which extends from spine to spine. The eggs of *Trichopepla semivittata* Say have much the same appearance in this respect and the membrane between the spines may well arise in the same manner.

While pentatomid eggs are in most cases white or whitish in appearance, there are also other colors. Seemingly white or whitish eggs

derive their color from the egg contents showing through the chorion. The eggs of colors other than white may derive their color in the same manner but in those of some species there is a pigment, but whether on or in the outer covering has not been determined. In eggs having colored shells, however, the color remaining after hatching is much less intense unless the shell is a black one, as in ***Perillus bioculatus*** Fabr.

Imms (1929) quotes Verson (without citation) to the effect that the chorion of insect eggs is not chitinous, its composition differing from chitin in that it contains sulfur and upwards of 17% nitrogen.

Subfamily **Pentatominae**

Genus **Euschistus** Dallas

The eggs of the species known to the writer are kettle-shaped and nearly white. The chorion is marked off by fracture-like lines which intersect to form triangles and at each intersection is an erect primary spine. The chorionic processes are apparently identical in shape in the eggs of the species studied but there seems to be a somewhat indefinite difference in their numbers, or rather in the range of variation. At hatching there is a tendency in this genus for the chorion to tear below the suture, leaving some of the processes adhering to the lid. The suture is not usually visible before the egg hatches, this being particularly true of preserved material.

Two of the species discussed below have been previously investigated to some extent. Parish (1934) has described the eggs of *E. variolarius*, but the measurements given are exactly half those obtained by the present writer, suggesting a discrepancy in reading the ocular micrometer. There is also some discrepancy as regards the number of processes, the above writer indicating a much smaller variation. Adair (1932) records some observations concerning the egg mass and incubation data on *E. euschistoides* but does not describe the egg itself.

Euschistus variolarius Palisot de Beauvois

Egg mass.—The egg mass is usually placed on the under side of foliage and each individual egg is placed in an upright position. Barring irregularities of the substratum, the eggs are neatly arranged in regular rows, the rows being mostly four in number, or in some cases five. The eggs are cemented to the substratum and to each other by a colorless adhesive secreted by the female at the time of oviposition. The masses ordinarily contain from 14 to 25 eggs, but may contain up to 40. The average is about 18.

Egg (figs. 1, 2, 3).—Length, 1.06–1.13 mm.; diameter, 0.92–0.99 mm. Form somewhat kettle-shaped, slightly larger near base, operculum only slightly convex. Just outside the operculum is a ring of 28–37 somewhat irregularly spaced, clavate chorionic processes, each about 0.07 mm. in length. Color of egg nearly white, some having a slightly greenish tinge when first deposited. Chorion reticulated as indicated for the genus, an acute, erect primary spine arising at the apex of each triangle, these being nearly as long as the processes. When the chorion is viewed under high magnification no reticulation is evident, its course being marked by a few secondary spines.

Euschistus euschistoides Vollenhoven

Egg mass.—The eggs and egg masses of this species do not differ appreciably from those of *E. variolarius*, the preferred place for oviposition being the under side of leaves and the eggs usually arranged in four or more straight rows. The maximum size of the mass, and likewise the average size, is somewhat greater than in the above species, the maximum obtained by the writer being 55 eggs and the average 21.7. Both these figures exceed the corresponding ones for the other two species of *Euschistus* studied.

Egg.—Length, 1.00–1.30 mm.; diameter, 0.92–1.03 mm. Form somewhat kettle-shaped, some of proportionately greater diameter than others. The sides may be straight or slightly curved, greatest diameter sometimes near base. Base usually slightly more convex than operculum. Color white or cream, due to visible contents. Reticulations and spines as in other *Euschistus* species. Chorionic processes 29–38, mostly 33–35. Processes about 0.06 mm. in length, rather narrowly attached at base, form more or less clavate.

Euschistus tristigmus Say.

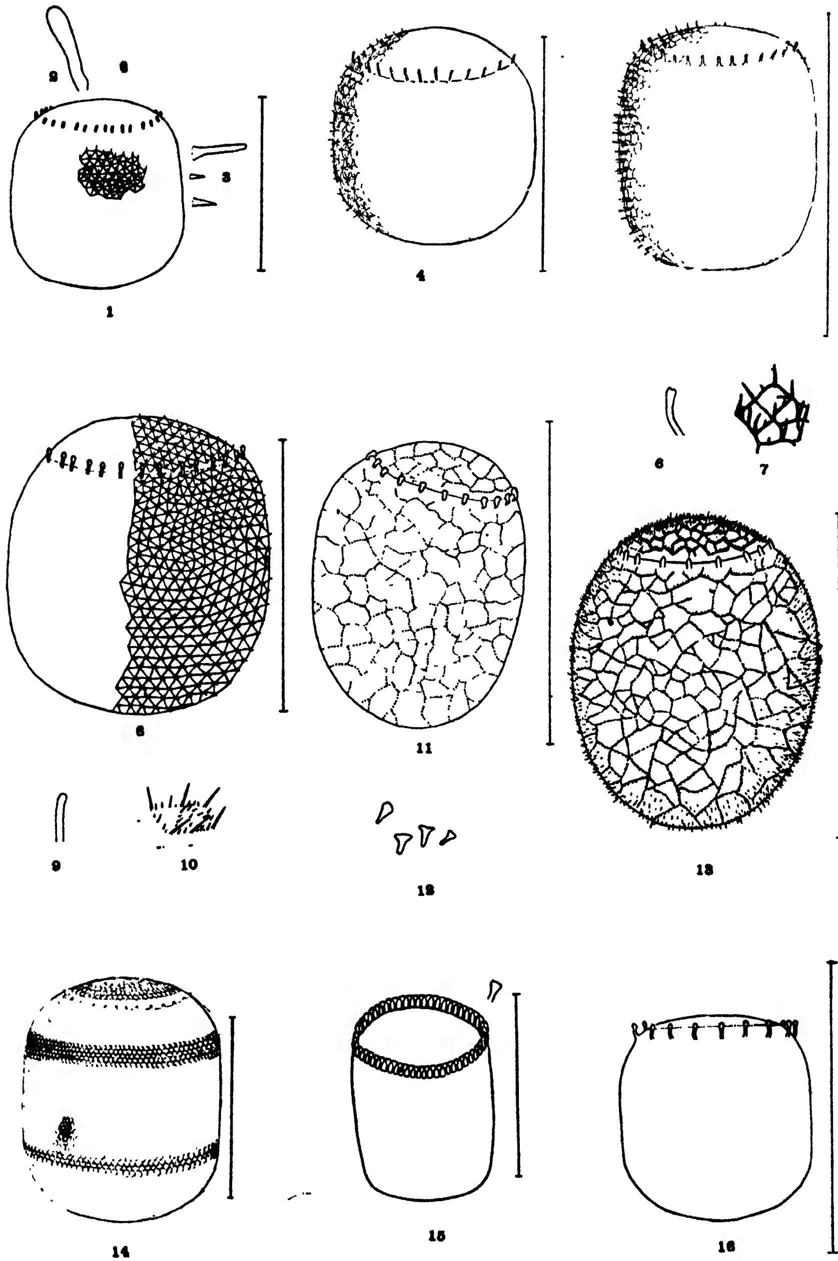
Egg mass.—The egg masses of this species are in general similar to those of the two preceding species but usually consist of fewer eggs, nearly always arranged in four rows. For some reason about 40% of the egg masses of this species consist of 14 eggs, typically two inner rows of 4 eggs each and two outer of 3 eggs each. In confinement the egg masses were placed in such a variety of places that one must hesitate to predict what might be the case in nature but a considerable number were found on the under side of foliage.

Egg.—Length, 0.95–1.00 mm.; diameter, 0.82–0.86 mm. Form somewhat kettle-shaped, varying somewhat in the ratio between length and diameter; base somewhat more convex than operculum, sides nearly straight. White interior shows through transparent chorion, the latter with triangular reticulations; erect, hyaline spines at each apex of the triangles. Chorionic processes whitish, 25–30 in number but most often 27–29. Processes about 0.06 mm. in length, slender at base and only slightly capitate.

EXPLANATION OF PLATE I

Gauge lines alongside drawings indicate 1 mm.

FIG. 1. Egg of *Euschistus variolarius* P. B. FIG. 2. Chorionic process of egg of *E. variolarius*, greatly magnified. FIG. 3. Assortment of chorial spines of egg of *E. variolarius*, greatly magnified. FIG. 4. Egg of *Peribalus limbolarius* Stål. FIG. 5. Egg of *Mormidea lugens* Fabr. FIG. 6. Chorionic process of egg of *M. lugens*, greatly magnified. FIG. 7. Details of chorial spines and reticulation of chorion in *M. lugens*. FIG. 8. Egg of *Coenus delius* Say. Fig. 9. Chorionic process of *C. delius*, greatly magnified. FIG. 10. Details of reticulation of chorion in egg of *C. delius*, showing it to consist of rows of spines. FIG. 11. Egg of *Neottiglossa sulcifrons* Stål. FIG. 12. Details of mushroom-like bodies which replace spines in reticulation of chorion in egg of *N. sulcifrons*. FIG. 13. Egg of *Trichopepla semivittata* Say. FIG. 14. Egg of *Murgantia histrionica* Hahn. FIG. 15. Egg of *Solubea pugnax* Fabr. and detail drawing of single chorionic process. FIG. 16. Egg of *Cosmopepla bimaculata* Thom.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Hymenarcys aequalis Say.

Egg mass. (fig. 29).—The six egg masses secured, all from one female in captivity, ranged in size from 4 to 13 eggs, three masses containing 7 eggs each. These masses consisted of two rows of eggs with the exception of one of the larger masses, in which two eggs were placed in a third row. Five of these masses were attached to the under side of leaves of a corn seedling and the other to the growing tip of a bean stem.

Egg.—Length, 0.70–0.82 mm.; diameter, 0.65–0.70 mm. Form kettle-shaped and more squat than egg of ***Mormidea lugens***, which it so closely resembles. Base quite convex, operculum only moderately so; maximum diameter near base, side walls straight or slightly constricted at middle. Chorion hyaline, reticulated, the reticulations consisting of a series of close-set secondary spines, these being longer, more robust, and apparently more numerous, than in ***M. lugens***, giving the egg a more spinose appearance; cells almost invariably triangles. Contents of egg remain white during embryonic development. Chorionic processes only slightly dilated at apex, 25–29 in number.

Mormidea lugens Fabricius

Egg mass.—The egg masses of this species are usually rather small and the writer has no record of more than one mass per female. The number of eggs per mass varied from 7 to 20, with most masses containing 10 eggs, which were arranged in either two or three rows. The masses secured by the writer from caged females have for the most part been placed upon the blades and flower panicles of blue grass, but also in a few instances upon foliage of bouncing bet (*Saponaria officinalis* L.) and evening primrose (*Oenothera* sp.).

Egg (figs. 5, 6, 7).—Length, 0.72–0.80 mm.; diameter, 0.60–0.67 mm. Form more or less ellipsoidal, curvature of ends about equal, sides only slightly arcuated, forming a rounded shoulder near ends. Chorion hyaline. Contents of egg white before embryonic development but later showing two roseate longitudinal bands and the entire contents eventually turning the same color. Chorion reticulated with raised lines, a primary spine arising at each intersection and with a few hairlike secondary spines arising from the reticulations and also within the cells. Cells not constant in form, having varying numbers of sides. Chorionic processes rather uniformly 25 in number, only slightly dilated at apex.

Coenus delius Say.

Egg mass.—The egg masses obtained from this species show such inconsistency that it is suspected they do not represent the normal condition. The various masses ranged in size from 1 to 20 eggs, but with half of them of 3 eggs or less. The larger masses show a tendency toward two rows of eggs but these were irregularly and loosely arranged.

Eggs (figs. 8, 9, 10).—Length, 0.92–1.24 mm.; diameter, 0.76–0.99 mm. Form usually ellipsoidal but some may be oval or may have straight sides. Both ends strongly convex. Chorion reticulated with rows of close-set secondary spines, the intersections marked by prominent primary spines. Secondary spines various, but large ones very

common. Secondary spines also common within cells formed by the reticulations. Chorion and accessories usually hyaline but spines, reticulations and processes rarely fuliginous. Processes mostly 26–29 in number, not perceptibly dilated apically (fig. 9). Compared with *Euschistus*, *Coenus* eggs are usually less squat, spines are apparently longer and more numerous.

Peribalus limbolarius Stål.

Egg mass (fig. 36).—Egg masses observed were attached to under side of leaves (red clover), stems and seed pods (*Lepidium campestre*) and most often consist of three rows of eggs or two and a partial third. The largest mass observed contained 28 eggs but, like *Euschistus tristigmus*, there is a pronounced tendency toward masses of 14, seventeen of forty-four masses containing this number. On occasions the eggs within a given mass may vary greatly in size (fig. 36), this variation amounting to 60% or more if based on volume.

Egg (fig. 4).—Length, 0.85–0.99 mm.; diameter, 0.67–0.81 mm. Form variable and frequently irregular. Length usually about 1.25 times the diameter. Base usually more convex than operculum. Color when freshly deposited bright lavender but becoming a beautiful old rose upon drying. Empty shells pale salmon. Reticulation present, most readily observed in hatched eggs. Chorionic processes small, clavate, paler in color than remainder of chorion, the number varying from 15 to 21 but 16 to 19 most frequent. Spines have somewhat the appearance of blond whiskers, the tips showing against the darker background as pinpoints of light color.

Menecles insertus Say.

Egg mass.—No information whatsoever concerning any of the immature stages of this species is to be found in the literature. The following information is based upon three masses of eggs oviposited by a single female. These three masses consisted of 13, 11 and 10 eggs. The masses were inclined to be irregular and some of the eggs were placed on their sides instead of in the customary upright position. These eggs were attaced to a leaf of *Polygonum* sp.; where they would be found in nature seems to be anybody's guess.

Egg (fig. 27).—Length, 1.38–1.48 mm.; diameter, 1.06–1.16 mm. Color white, due to egg contents showing through chorion. Form somewhat ovoid, side walls curved, but usually not with same curvature on the two sides of the egg. Greatest diameter somewhat nearer the top, curvature of ends about equal, quite convex. Chorionic processes about 30, small and inconspicuous, irregularly clavate. Chorial spines present, ranging from pyramidal to almost setose, forming an irregular network but without the reticulated appearance observed in the species described heretofore.

Trichopepla semivittata Say.

Egg mass.—Caged individuals have in general refused to oviposit upon such food material as was provided, utilizing instead the wire screen of the cage or the disc of paper towel on the floor of the cage.

Those attached to the paper floor of the cage were all attached to the lower surface, which might indicate a similar habit on foliage. Blatchley (1926) reports taking it in all stages on *Eryngium yuccifolium*.

The egg masses are most commonly made up of three rows with frequently one or two eggs starting another row. The tendency toward precisely 14 eggs per mass is most pronounced in this species, such being the case in exactly two-thirds of the 21 masses examined. In the remaining masses the number of eggs ranged from 11 to 28.

Egg (fig. 13).—Length, 0.88–0.93 mm.; diameter, 0.67–0.70 mm. Form somewhat ellipsoid, ends strongly convex, sides nearly or quite straight for a short distance near middle. Chorion translucent gray with reticulations consisting of castaneous to fuliginous spines webbed together by membrane of same color. Chorionic processes 15 to 20 in number, but mostly 16 to 18, white apically, not dilated at apex. Operculum usually somewhat askew. No spines or reticulations about margin of operculum or between opercular suture and chorionic processes. Opercular suture readily discernible.

Neottiglossa sulcifrons Stål.

Egg mass (fig. 35).—The eggs obtained from caged individuals have been found in various situations, including foliage and on the glumes of grasses, but most frequently upon the slender branches of blue-grass panicles. In the latter situations the mass invariable consists of two regular rows of eggs, but when deposited upon the glumes and foliage the masses show a decided tendency toward several rows and also increased irregularity in arrangement. The masses so far observed ranged in size from 2 to 14 eggs but for the most part from 7 to 12. The larger masses nearly always have one or more eggs in a prostrate position.

Egg (figs. 11, 12).—Length, 0.83–0.92 mm.; diameter, 0.56–0.60 mm. Form elongate oval, ends quite convex. Color cream to dirty white with somewhat translucent reticulations, consisting of small, irregular areas fenced off by what appear to be single, wavering rows of angular granules but are actually the greatly dilated ends of mushroom-like outgrowths. Chorion nearly hyaline but becoming somewhat yellowed in preserved specimens. Chorionic processes very minute, apparently about 20 in number.

Neottiglossa cavifrons Stål.

Egg mass.—Only two egg masses have so far been obtained from this species and the observations given below are therefore based upon

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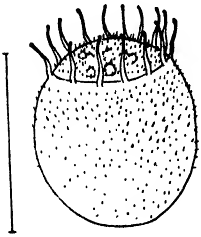
EXPLANATION OF PLATE II

FIG. 17. Egg of *Podisus maculiventris* Say. FIG. 18. Egg of *Perillus bioculatus* Fabr. in hatched condition, showing egg-burster hanging on lip of opercular opening. FIG. 19. Egg of *Apateticus* sp. FIG. 20. Egg of *Acrosternum hilare* Say. FIG. 21. Chorionic process of egg of *A. hilare*, greatly magnified. FIG. 22. Detail drawing of pits in chorion of egg of *A. hilare*, greatly magnified. FIG. 23. Egg of *Brochymena* sp. FIG. 24. Chorionic process of egg of *Brachymena* sp., greatly magnified. FIG. 25. Egg of *Thyanta custator* Fabr., showing pits and color bands. FIG. 26. Egg of *Chlorochroa persimilis* Horv. FIG. 27. Egg of *Menecles insertus* Say.



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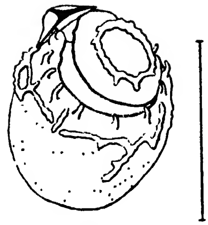

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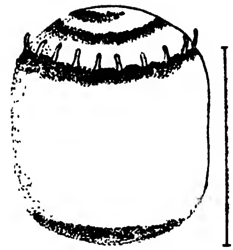

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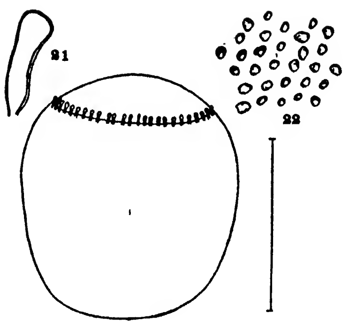

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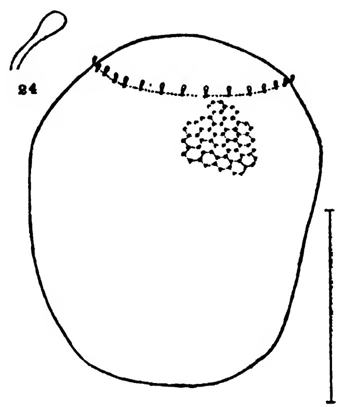

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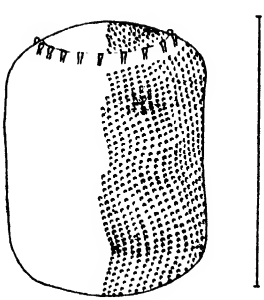

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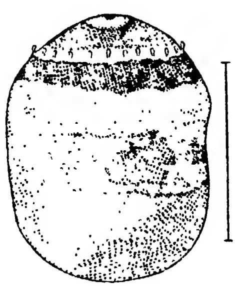

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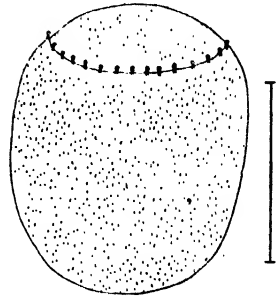

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very limited material. The above masses were both deposited upon blue-grass and differed in no respect from those of the above species. These two masses were each composed of two straight, compact, interlocking rows and consisted of 10 and 11 eggs respectively. One was attached rather insecurely to the side of the glumes of the blue-grass and the other to one of the slender branches of the panicle, the bases of the eggs in this latter mass being laterally attached to the stem.

Egg.—Measurements were made with a less accurate measuring device than used heretofore but the eggs, by comparison seemed to be equal in size to those of *N. sulcifrons.* Length, 0.80 mm.; diameter, 0.54 mm. No visible difference from the above were noted except that the color was roseate during the first two or three days following oviposition.

Genus **Chlorochroa** Stål

The writer has had only one species, *Chlorochroa persimilis* Horv., available for study. There is, however, literature treating of two other species, both of some economic importance. In order to get this information together, pertinent parts of the descriptions of these two species will be included in this paper.

Chlorochroa persimilis Horvath.

Egg mass (fig. 28).—The eggs of this species have not been found in the field by the present writer, although a search was made on the food plant itself (*Opuntia*) and on nearby weeds and grasses. Confined females deposited their egg masses on various parts of the cage and less frequently upon the *Opuntia* fruits which had been provided as food. The egg masses of this species do not seem to follow any definite pattern but most often contain about four rows of eggs. While the rows are reasonably straight, the eggs are somewhat less compactly arranged than in most species. The maximum number of eggs per mass was 43 and the average 21.3.

Egg (fig. 26.—Length, 1.35–1.55 mm.; diameter, 1.05–1.25 mm. Form subcylindrical, usually slightly constricted at middle, bottom end rounded off, usually asymmetrically so. Greatest diameter attained a short distance below ring of chorionic processes. Side walls and base of egg shining ivory white, with deep, concolorous punctures. Surrounded by this ivory white, and usually in the form of a broad band about the egg, is a sunken blotch or blemish of sepia brown, which may be either impunctate or very shallowly punctate. Sepia area may contain an irregular blotch of punctured white like the surrounding area. Just above the upper shoulder of the egg, and extending to just below the ring of chorionic processes, is a ring of bluish gray with deep, concolorous punctures and usually considerably broader on one side of the egg than on the other. Just above this ring is a narrower ring of snowy white, flaky appearance covering opercular suture and containing in its outer edge the ring of 25 to 30 chorionic processes; this ring of white is usually slightly elevated. Chorionic processes are short, white, clavate. Inside this ring, on operculum, is another ring of bluish gray then another of shining ivory white, which in turn has a bluish

gray center. Smaller ring and center spot irregular, center spot impunctate. Bluish gray portions change to sepia during embryonic development. In empty shells, portions formerly sepia or gray become transparent; white portions become milky, translucent.

Chlorochroa sayi Stål.

According to Patton and Mail (1935), most egg masses were found on old wheat stubble, but also on Russian thistle where latter predominated. The egg masses deposited on old wheat stubble were usually arranged in two rows and contained 14 to 35 eggs but on larger surfaces the masses were found to be more or less shapeless. A half-tone illustration of an egg mass is included in the above paper.

Caffrey and Barber (1919) also studied what is supposedly the same species as the above but, in view of certain rather glaring discrepancies, this is open to some doubt. It is in the latter publication that the description of the egg is found.

Egg.—Length, 1.1–1.2 mm.; diameter (maximum), 0.88–0.93 mm.; diameter at bottom, 0.57–0.66 mm. The egg is irregularly ovoid in form, with irregular gray areas on the lateral surface, in appearance resembling froth. Viewed from above, three white circles appear, inclosing a central dull-gray area and two circular bands of the same color.

Chlorochroa ligata Say.

The bulk of the work on this species has been done by A. W. Morrill, no less than four papers by this author being at hand. It is from these papers, principally that of 1910, that the following data have been taken.

Egg mass.—The egg masses are apparently deposited on various parts of the food plant, at least this seems to be true on cotton. The maximum number of eggs recorded per mass is 79 and the average 28.4. The above writer calls attention to the frequency with which eggs are deposited in multiples of 14, 28 being the most frequent and 42 next. No information is given as to the form of the mass but, judging from the number of eggs, there are likely several rows.

Egg (from Morrill, 1905, 1910). Diameter about .9 mm. and height about 1.2 mm. There are three distinct parts of the egg which may be termed body or lower part, neck or intermediate part, and the lid or cap. The last named portion usually remains attached by a hinge after the hatching of the young. The body, height of which is about two-thirds that of the entire egg, is subcylindrical, being constricted in the middle, rounded more or less at the lower end, and at the upper abruptly curving inward to meet the neck. The width of the neck on the side (dorsal) opposite the hinge of the cap is about one-sixth of the entire height of the egg, and on the ventral side about one-third as wide as on the dorsal side. On the upper margin of the neck are pure white blunt processes, numbering as a rule 22. The cap is subconical, diameter at base two-thirds of diameter of body of egg, height one-fourth or one-fifth the diameter of base, apex rounded or somewhat flattened. The appearance of the egg is affected by translucent and opaque areas, which seem to be due to the absence and presence of a

coating of wax. The cap is translucent, except for the edge, and the neck is translucent, except for its upper edge adjoining the cap, the translucent areas are quite dark. In some of the empty shells of the same batch of eggs the translucent areas remain clear, though not transparent, and in some they become yellowish. The entire chorion is closely and finely punctate, the punctures in the transparent parts being smaller than on the opaque parts.

Thyanta custator Fabricius

Egg mass (fig. 34).—The egg masses of this species usually consist of four to eight straight rows of eggs securely fastened together and to the substratum. The maximum number of eggs observed per mass was 72 and the average for 50 masses was 35.4. What surface is chosen for oviposition in nature has not been determined; confined females usually utilize the sides of the cage.

Egg (fig. 25).—Length, 0.94–0.98 mm.; diameter, 0.74–0.77 mm. Form cylindrical with convex ends, latter having approximately equal curvature. Chorion somewhat calcareous in appearance, two-tone gray or buff in color, side walls of the lighter shade except for two rather irregular bands near top and bottom, operculum of darker shade with rounded spot of paler shade in center. Chorion with rounded pits, not transparent; chorionic processes small, 18 to 22 in number, slightly capitate.

Acrosternum hilare Say.

Egg mass.—The place chosen for oviposition varies considerably for this species. According to Underhill (1934), if the host plant has flat fruit pods, most of the masses are placed there, otherwise the great majority are placed upon foliage, with apparently little preference for either surface.

The egg masses of this species sometimes attain considerable proportions, the maximum secured by the writer in rearing being 69, which is appreciably larger than that obtained by Whitmarsh (1917), Underhill (1934) or Sorenson and Anthon (1936), all of whom have worked with this species. The average size of the mass is, however, only about half this figure. It seems to be the general rule that the first mass deposited by a female is the largest, the others gradually diminishing in size.

The form of the egg mass in this species is less definite than in most pentatomid species. The eggs are placed on end and in several fairly

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EXPLANATION OF PLATE III

FIG. 28. Portion of egg mass of *Chlorochroa persimilis* Horv. FIG. 29. Egg mass of *Hymenarcys aequalis* Say. FIG. 30. Egg mass of *Cosmopepla bimaculata* Thom. about to hatch, egg-burster and eye-spots showing through operculum. FIG. 31. Egg mass of *Brochymena* sp. clustered about stem of *Laportea canadensis* Linn. FIG. 32. Portion of egg mass of *Podisus maculiventris* Say deposited upon wire screen. FIG. 33. Egg mass of *Solubea pugnax* Fabr. on leaf of *Geum laciniatum* Murr. FIG. 34. Egg mass of *Thyanta custator* Fabr. on wire screen. FIG. 35. Egg mass of *Neottiglossa sulcifrons* Stål on seed pod of *Lepidium campestre* (L.) R. Br. FIG. 36. Egg mass of *Peribalus limbolarius* Stål, showing variation in size of eggs.

PLATE III

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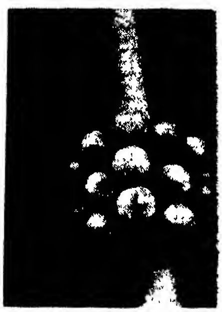

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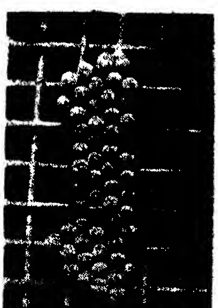

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definite rows, but the adjacent rows are not usually tightly interlocked as in most species.

It is interesting to note that the eggs may be either lemon yellow or yellowish green in color, but all eggs within a given mass are the same color. According to Whitmarsh (1917), the color is peculiar to the particular female, but Underhill (1934) states that under field conditions about 85% of the masses are of the green variety, while under laboratory conditions fully 50% show some yellow.

Egg (figs. 20, 21, 22).—Length, 1.40–1.50 mm.; diameter, 1.20–1.25 mm. Form somewhat cup-shaped, sides may be slightly arcuated or straight at middle, usually with a perceptible shoulder a short distance from margin of operculum. Operculum moderately convex, base more strongly so but blending into side walls without forming a shoulder. Chorion hyaline, contents showing through, varying in color from lemon yellow to pea green in newly deposited eggs. During embryonic development, the yellow eggs become roseate and the green ones cinereous. Chorion with definite, but somewhat wavering, rows of angular punctures. Chorionic processes 45 to 65 in number, rather strongly clavate (fig. 21), leaving egg at right angles, then turning abruptly upward. Opercular suture plainly visible.

Murgantia histrionica Hahn

Egg mass.—Only one egg mass of this species has been available for study, this consisting of two rows of eggs, which is indicated in published literature to be the regular condition. The masses are said to consist of about 12 eggs each and attached to the under side of the leaves of the host plant, which is in most cases one of the Cruciferae.

Egg (fig. 14).—Length, 1.30–1.38 mm.; diameter, 0.90–0.92 mm. Form cylindrical, giving rise of pronounced shoulders at the ends. Ends somewhat flattened, of approximately equal curvature. Eggs marked by two fuscous transverse bands on side wall and a crescent of same color on margin of operculum. Upper band located immediately below upper shoulder and is half again as broad as lower band. One rounded fuscous spot midway between bands. Crescent on operculum of about same width as upper band and tends to be located on side most remote from adjoining eggs of the mass. Remainder of egg surface, including lower end, whitish. Entire chorion has very finely reticulated or cellular appearance, this latter seeming to extend to some depth. Processes extremely minute, about 30 in number.

Cosmopepla bimaculata Thomas

Egg mass (fig. 30).—The egg mass may be attached to any of various surfaces, such as the foliage or stem of the plant. Unlike other species so far investigated, this one did not hesitate to oviposit freely on such hairy surfaces as that provided by common mullein, *Verbascum thapsus.* In the case of this species oviposition is recorded by two previous writers. Olsen (1910) has bred them from egg to adult upon moth mullein, *Verbascum blattaria* L., but it is to be assumed that this was in confinement. Balduf (1926) found them ovipositing upon cultivated snapdragon. Olsen (loc. cit.) says they oviposit on any part of the plant.

The egg masses obtained by the writer have varied from 2 to 24 eggs, which is a higher maximum than that reported by the above authors. The average of the various masses has been about 11 eggs.

The arrangement of the eggs in the mass varies considerably, those deposited on stems usually consisting of two rows with sometimes a partial third, those on foliage and other broad surfaces being inclined to lack definite form.

Egg (fig. 16).—Length, 0.74–0.85 mm.; diameter, 0.55–0.71 mm. Form kettle-shaped, varying somewhat in degree of elongation. Color varies from pale greenish-yellow to deep golden yellow and is due to contents, the chorion being entirely hyaline, shiny, devoid of spines or sculpturing. Operculum somewhat less convex than base. Chorionic processes of moderate size, strongly capitate, 15 to 22 in number.

Solubea pugnax Fabricius

Egg mass (fig. 33).—This species is probably not very specific as to the plant upon which it oviposits. Garman (1891) states that it oviposits upon *Setaria* and *Panicum*, and Douglas (1939) reports oviposition on stems, leaves and panicles of rice. In confinement it oviposited upon practically anything offered. The masses varied in size from 8 to 44, consisting of two rows of eggs.

Egg (fig. 15).—Length, 0.86 mm.; diameter, 0.65 mm. Form cylindrical except for being rounded off at base. Full diameter carried to edge of operculum, forming a decided corner, from which the chorionic processes arise. Processes white, decidedly clavate, 67 to 72 in number, contiguous. Head of each process comprises about half its length and has a diameter about three times that of stem. Color of egg apple green, due to visible contents but red markings appear as embryo develops. Red marking on operculum takes the form of the letter "W." Chorion devoid of spines but under high magnification can be seen to be sculptured with sparse, tiny elevations arranged in irregular, transverse, undulating rows which do not intersect.

Brochymena sp.

Egg mass (fig. 31).—The writer found a mass of 14 eggs clustered around a stem of the woods nettle, *Laportea canadensis* L. in a tract of University woodland. Lacking further material from caged individuals, it was necessary to depend upon other sources for identification. Fortunately some of Hart's (1919) material was still available in the collection of the Illinois State Natural History Survey, definitely establishing it as belonging to *Brochymena* sp. Unlike any other egg mass of this family seen by the writer, this particular one completely surrounded the stem. Blatchley (1926) has recorded an already hatching mass of eggs of *B. quadripustulata* Fabr. on the under side of a leaf of skullcap, *Scutellaria nervosa* Pursh. His description of the eggs, however, lacks sufficient detail to make determination possible. Since the genus is an arboreal one, these two instances of oviposition on herbaceous plants might seem rather out of character, but the writer has also taken even the smallest nymphs from vegetation growing beneath trees. At any rate no other oviposition records for this genus seem to be available.

Egg (figs. 23, 24).—Length, 1.8 mm.; diameter, 1.3 mm. Maximum diameter attained at a point near top of egg, making a rather abrupt shoulder. Chorionic processes about 27 in number and distinctly capitate (fig. 24), minute compared to size of egg. Chorion hyaline, egg translucent gray in color. Sculpturing consists of pits or punctures in hexagonal arrangement but not connected by any visible reticulations. Opercular suture well defined, bordered outside by thin impunctate ring.

Subfamily **Asopinae**

Podisus maculiventris Say.

Egg mass (fig. 32).—The arrangement of eggs in the mass is not nearly so precise in this species as in most of the phytophagous species studied but they are still arranged in fairly definite rows, although not so closely spaced. The number of rows of eggs in the mass is usually about four. In further contrast to the phytophagous species, this one usually deposits upon the upper side of foliage, unless the lower one happens to be more strongly lighted. Under rearing conditions the masses are more often found on some part of the cage. The egg masses of this species are of moderate size, the maximum number of eggs per mass observed was 57 and the average 25.

Egg (fig. 17).—Length, 0.95–1.05 mm.; diameter, 0.86–0.93 mm. Form subglobose to oval, operculum slightly more flattened than base. Color of chorion varies from pale yellow to gunmetal, except the spines, which are usually fuscous to black. Spines on operculum longer, forming a reticulum and more or less connected by a dark, foliaceous membrane which sags considerably between spines. Margin of operculum and top of side wall marked by a laevigate ring, from the lower margin of which arises the circle of chorionic processes. Processes usually 15 to 17 in number, about one-fourth as long as the egg itself, once sinuated, capitate, and with slender neck just below the terminal knob. Chorial spines on lower portion of egg shorter than those above.

Perillus bioculatus Fabricius

Egg mass.—The oviposition habits are similar to those of *Podisus maculiventris*, the egg mass being usually deposited in some exposed location. In the field the eggs are usually deposited upon the upper surface of a potato leaf or on the rachis, but in the laboratory they are deposited in as many cases on the sides of the cage or on a piece of cloth or paper hung in the cage for that purpose, the latter being a device used by Couturier (1938) in rearing the preceding species.

In the limited rearing work carried on by the present writer, the masses consisted of 7 to 32 eggs, the average being about 16, but with no tendency toward any particular number. Knight (1922) indicates that normally the mass consists of two fairly straight rows but the present writer did not find this to be the case except when deposited upon a narrow surface, such as the petiole or rachis of the potato leaf.

Egg (fig. 18).—Length, 1.05–1.20 mm.; diameter, 0.77–0.95 mm. Form varies, but most often is somewhat elongate with greatest diameter above middle and forming a truncated cone above shoulder. Cho-

rion generally piceous but may be diluted to blackish or fuscous, or rarely golden yellow; coarse ridges of same color as remainder of chorion stand out in irregular relief on upper half of egg, diminishing gradually to irregular, evanescent rows of short, pyramidal spines. Operculum with raised ring of same appearance as ridges on upper half of egg. In transparent specimens this can be seen as a ring of spines covered with a serous secretion. Chorionic processes broadly attached to chorion, curving upward and having a small apical knob, preceded by a short slender neck, concolorous with chorion and 12 to 18 in number, usually 13 or 14.

Genus **Apateticus** Dallas

The eggs described below are unfortunately not associated with the adult stage of the species, making it necessary to rely solely upon circumstantial evidence for determination. The first and principal clue to their identity is the fact that the mass was collected in the dead of winter. The eggs are very evidently those of a pentatomid and the only record of overwintering eggs in this family pertained to the above genus (Downes 1920, Stone 1939). Stone gives no description of the eggs of *A. cynicus* Say, from which he did some subsequent rearing and Downes gives only a brief general description of the eggs of *A. crocatus* Uhl. but such material as is available is at least not contradictory to the above tentative determination. The species here under consideration is most likely *A. cynicus* Say. Incidentally, the egg mass figured in Parshley (1923), Plate XIX, fig. 7, as *Podisus* sp. is in all likelihood a species of *Apateticus*, at any rate it certainly is not *Podisus*.

Egg mass.—The mass referred to above consisted of two rows of eggs set, in the usual compact manner, on a twig which seemed to be from an apple tree. The number of eggs in this mass is not now known to the writer, but was rather large, probably about 40.

Egg (fig. 19).—Length, 1.25–1.35 mm.; oval in cross section, diameters approximately 1.10x1.20 mm. Form, in lateral view, approximately ellipsoidal but with a rather abrupt shoulder just below the ring of chorionic processes. Color (preserved specimens) pale yellowish, with basal end of egg, a band beneath ring of chorionic processes and two concentric rings on operculum fuscous. Surface of chorion with contiguous, large shallow depressions, giving a finish resembling that of hammered brass. Chorionic processes about 16 to 18 in number, broadly and perpendicularly attached at base, but immediately bending in such a manner that the processes follow parallel to curvature of operculum. Points of attachment of processes located along upper margin of the fuscous band and apices reach outer margin of larger fuscous ring on operculum; apices of processes not dilated.

NOTES ON PHYLOGENY

As regards the determination of the phylogeny, it soon becomes apparent that the material at hand is inadequate. Whether the study of other existent forms will serve the purpose is yet to be seen; some of the fundamental links may already be extinct.

The question arises as to whether the evolution of the eggs need

necessarily be in line with that of the other stages. It seems possible that the species showing the most specialization, as judged by the adult, may have one of the more generalized eggs. The egg could well be a holdover from some ancestral form or it could, on the other hand, represent all or most of the evolutionary changes which the species has undergone. It seems, however, that the evidence furnished by a study of the eggs cannot be ignored when the phylogeny is to be determined.

As regards the separation into subfamilies, little material is yet at hand, the only such groups concerned in the present study being the Asopinae and the Pentatominae. The only common points of difference noted between these groups is in regard to the chorionic processes, these showing a tendency toward smaller numbers and greater development in the Asopinae. In the instances so far noted the processes in this group are broadly and strongly attached at the base and the insertion is approximately perpendicular to the curvature of the egg, the processes then being bent abruptly upward and following approximately the curvature of the operculum for at least a part of their length. To what extent this character will hold in other genera of this subfamily can only be conjectured, but has been found to be true for members of the three genera included in this paper and is further supported by published illustrations of *Zicrona caerulea* Linn. (Kershaw & Kirkaldy, 1909) and *Oechalia grisea* Burm. (Kirkaldy, 1907).

The bulk of the material in the present paper concerns species included in the tribe Pentatomini. The diversity of character of these species is so great as to indicate further subdivision may be in order.

The generic arrangement in this tribe in the various works seems generally to follow that in Van Duzee's catalogue, which in turn is based on Reuter's classification, but if it is intended to represent even an approximation of phylogenetic relationships, there is sufficient material provided here to offer some strong contradictions. The Van Duzee arrangement seemingly cannot possibly represent relationships. The sequence *Peribalus*, *Trichopepla*, *Chlorochroa*, *Mormidea* and *Solubea* seems to have no significance whatsoever from the standpoint of egg types, only *Peribalus* and *Mormidea* having anything in common. Further down the list we find the genera *Hymenarcys*, *Neottiglossa*, *Cosmopepla*, *Menecles* and *Thyanta* in that order but with a few other genera sandwiched between. These have no closer relationship to each other than do those of the earlier sequence, but two represent a repetition of types found above. Blatchley (1926), on the other hand, has divided the Pentatomini into three subtribes, a scheme which seems to be much more in line with the present findings. *Chlorochroa* and *Thyanta*, whose eggs are very similar, fall into the same subtribe but along with *Peribalus* and *Trichopepla*, which do not seem to belong with them or with each other. The genera *Mormidea*, *Euschistus*, *Hymenarcys* and *Coenus* are also brought together, which is proper, but are accompanied by extraneous material.

In attempting to determine the primitive type of egg we are again hindered by limitations of material. If we consider the larger number of chorionic processes as being an indication of a more primitive condition, *Solubea* and *Acrosternum* head the list, having about twice as

many processes as most of the others, but it also indicates the Asopinae as being the most specialized, a premise which is not generally accepted.

It would perhaps be well to discuss briefly in this connection a few of the characters which the eggs of certain genera have in common. One such is the presence of pits in the chorion, which are to be found in *Chlorochroa*, *Thyanta*, *Acrosternum* and *Brochymena*. Of these the first two genera seem to be definitely related, the pits being similar and the evidence is further supported by pigmentation in the chorion itself and other points of similarity, but *Acrosternum* and *Brochymena* do not seem to belong in this category. Whereas in *Chlorochroa* and *Thyanta* the pits are round and rather deep, much like the so-called "punctures" on certain parts of many of the nymphs and adults, those on the eggs of *Acrosternum* are irregularly angular in shape, the chorion lacks pigment and the chorionic processes are numerous and strongly clavate, being attached by only a slender pedestal. While the pits of the chorion of the eggs of *Brochymena* are puncture-like, they are so arranged as to suggest some sort of parallelism with the primary spines on such eggs as those of *Euschistus*, but there seems to be no further relationship with the other pitted eggs. The assigned position of *Brochymena* in another tribe (Halyini) is probably justified.

The matter of reticulation of the chorion also seems worthy of some discussion. To a considerable degree it seems to be tied up with the presence of spines. Indeed, in most instances the reticulation consists of thick-set rows of spines. Only in *Mormidea* has there been found to be an actual raised network, although all those in this category seem to have such until seen under the compound microscope. In *Neottiglossa* the reticulated effect is produced by rows of mushroom-like bodies whose dilated distal ends are contiguous and conceal their points of origin. They would seem to be homologous with the spines on the eggs of such genera as *Euschistus* and *Coenus*.

In *Trichopepla* the spines are webbed together and the basic nature of the reticulation is obscured. The eggs of *Murgantia* have a very finely reticulated appearance but there are no spines and the reticulation seems to be beneath the surface, which would seem to remove it from this category. This is also supported by the peculiarity of the chorionic processes. These are so minute as to suggest that they may have become vestigial, thus indicating a position near the top of the phylogenetic tree. *Menecles*, too, seems to occupy a unique position, it has spines but no trace of reticulation.

In quite another category we find *Cosmopepla* and *Solubea*, whose chorion is essentially devoid of sclupturing or spines. Here, however, the similarity ends. *Cosmopepla* has comparatively few processes, those of the conventional type, and the operculum is very ordinary except for the lack of ornamentation. In *Solubea* the chorionic processes are not only the most numerous of any of the genera studied, but also the largest, thus forming a practically contiguous ring. The operculum, too, is radically different, being almost perfectly flat and occupying the entire anterior end of the egg. This seems to be about the ultimate in everything. Is it the beginning or the end in evolutionary development? It certainly seems to have no near relatives.

KEY TO THE KNOWN EGGS OF PENTATOMIDAE

1.	Chorion reticulated	2
	Chorion not reticulated	9
2.	Spines webbed together by a serous membrane	3
	Spines not webbed together	4
3.	Processes long, equal to radius of operculum	**Podisus**
	Processes short, 3 or 4 times as long as thick	**Trichopepla**
4.	Chorion transparent or whitish	5
	Chorion opaque, or at least not whitish	8
5.	Eggs larger, mostly more than 0.95 mm. long	6
	Eggs smaller, mostly less than 0.80 mm. long	7
6.	Form kettle-shaped, base more convex than operculum	**Euschistus**
	Form ellipsoidal, ends of equal curvature	**Coenus**
7.	Form ellipsoidal, spines hairlike	**Mormidea**
	Maximum diameter usually below middle, spines coarse	**Hymenarcys**
8.	Egg spinose, operculum rather flat	**Peribalus**
	Egg not spinose, operculum very convex	**Neottiglossa**
9.	Eggs spinose	**Menecles**
	Eggs not spinose	10
10.	Processes less than 40 in number	11
	Processes 45 or more in number	17
11.	Chorion pitted	12
	Chorion not pitted	14
12.	Form obovate, no banded colors	**Brochymena**
	Form subcylindrical, banded colors in fresh material	13
13.	Processes clavate, inserted on elevated white ring	**Chlorochroa**
	Processes not dilated at end, no white ring as above	**Thyanta**
14.	Eggs banded with black	15
	Eggs of solid color	16
15.	Black bands remote from ends, chorionic processes minute	**Murgantia**
	Black bands at base and shoulder, processes plainly visible	**Apateticus**
16.	Eggs black, operculum crested	**Perillus**
	Eggs yellow, operculum unadorned	**Cosmopepla**
17.	Chorion pitted, operculum with moderate curvature	**Acrosternum**
	Chorion not pitted, operculum virtually flat	**Solubea**

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A REVISION OF THE SPHAEROPHTHALMINE MUTILLIDAE OF AMERICA NORTH OF MEXICO

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This revisionary paper is the result of study of over thirty thousand specimens of Photopsidinae Mutillidae, including all but a few of the types. In view of its length, it has been divided into a number of sections, each of which will deal with one group.

Our knowledge of the group, as it is in the literature, is very incomplete. Perhaps less than one-half of the North American species have been described. Most of those that have been described have been so briefly characterized that correct determination is practically impossible. The existing keys, utilizing largely superficial characters of no or little phylogenetic value, make determination of the described species a matter of chance. For these reasons, brief characterizations of the described species, based on the type, giving the salient characters that have been omitted in the original descriptions are given. For a description of the color characters and other superficial characters, the student is referred to the original diagnoses.

Since many species probably still await description, and since the status of the described forms is often largely a matter of conjecture, above all, since the males and females have been correlated in but a very few cases, a monographic study of the group is out of the question at this time. However, in the present treatment, an entirely different classification of the group is adopted, whose ramifications will be discussed in the second part of this paper, and some attempt has been made to arrange the groups phylogenetically. There are still many points regarding the relationships of and within the group that have to be settled, and no final, lasting classification of the genera can be attempted until the males and females have been correlated. It is to be hoped that this study, making determination of the species possible, will stimulate enough collecting and field observation, that sufficient material and enough data will accumulate to make correlation of the sexes possible.

Discussion of the taxonomy of the group, and keys to the genera and subgenera will follow in the next paper in this series.

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Genus **Protophotopsis** n. gen.

In working over extensive collections of the nocturnal Photopsidine Mutillidae, several specimens of a diurnal black, male Mutillid wasp were found. These specimens, representing an undoubtedly discrete new genus and species, are of interest in that they appear to represent a species of a relict genus, standing near the stock, or ancestral form, of the round-eyed New World Mutillidae. In its several primitive characters it approaches the hypothetical ancestral form, perhaps an invasion from the Old World, from which have evolved our largely nocturnal genera (*Photopsis*, *Sphaerophthalma*, etc.) on one hand, and several distinct lines of diurnal genera (*Pseudomethoca*, *Lomachaeta*, *Hoplomutilla*, *Dasymutilla*, etc.), on the other hand. The genitalia of the present genus are very generalized, as can be seen by inspection of the figure, and differentiate it from all other Photopsidine wasps. In fact, in the general facies of the genitalia (digitus vosellaris longer than cuspis) it approaches nearer *Pseudomethoca* than the Photopsidines.

The lack of complete parapsidal furrows, short flagella, with the articles largely broader than long, long felt lines of the second sternite, nodose petiole, close, even sculpture, small ocelli, lack of plumose hairs, convex, poorly developed clypeal region, all indicate that we are dealing with a relatively generalized form. The genus is side-wise specialized, however, in regard to the prominent hyaline setae of the apices of the abdominal segments, which serve to adequately differentiate it from all other Mutillid genera known to me, except only the entirely unrelated *Rhopalomutilla*, which may have similarly, but less prominently developed setae.

Male: Head subquadrate, its width considerably less than that of the thorax, rather well-developed behind the eyes (length behind eyes considerably greater than length of eyes); mandibles obliquely tridentate apically, rather broad, carinate basally on dorsal margin, entire beneath, neither emarginate nor dentate; eyes subovate in outline, strongly convex, moderately large, distinctly facetted; clypeus convex, weakly developed, not produced anteriorly; antennal scrobes with a glabrous oblique tooth or ridge above; antennal tubercles prominent, not approximate; scape a sixth longer than the pedicel plus first two flagellar segments, with a strong, sharp carina running its entire length below; pedicel and first flagellar segments short, transverse, subequal in length, scarcely more than half as long as the elongate second flagellar segment; ocelli small, the maximum diameter of the posterior less than a fifth their distance from the eyes; punctures of head very close to confluent, moderately large, but not very coarse, deep, with well-defined narrow

intervals. *Thorax* evenly, closely punctured, with the pronotum provided with epaulets (a pair of micropunctate areas, somewhat depressed, bearing a rather prominent tuft of very fine silvery hairs, located somewhat mesad and apicad of the humeri); mesonotum without a trace of parapsidal furrows; mesopleura evenly swollen, not evidently obliquely sulcate and divided into a dorsal and ventral region; mesosterna unarmed; metapleura with the dorsal depression on each side very marked, pit-like; tegulae small, convex, lacking any recurved or reflexed margin; propodeum evenly convex and closely coarsely punctured, not reticulated. *Abdomen* with the petiole considerably widened to apex (about two and one-fourth as wide at apex as at base), but moderately elongate (longer than wide apically), distinctly petiolate and nodose, the apical constriction of the tergite very marked, and the second tergite considerably narrowed to receive it; tergites one to five and sternites two to five each with a prominent subapical row of hyaline, colorless, curved, aciculate setae; the pubescence simple, sparse, erect; well-developed felt lines present on second sternite as well as on second tergite; puncturation of abdomen close, moderately coarse, deep. *Legs* with the paired white calcaria; the tibiae with the dorsal spines in apparently three rows of four or five to seven slender setae; tarsi with a weakly developed apical row of setae on each segment, but totally lacking any ventral rows of setae or spines. *Wings* with cell R_1+R_2 less than half as wide as cell M_4, less than two-fifths its area, not more than three-fifths its length; cell 2nd R_1+R_2 acuminate apically, nearly three times as long as high; distance between origin of free part of vein M and the stigma scarcely over half the length of the stigma; free part of vein M one-third as long as m-cu; free part of M_{1+2} one-third as long as free part of M_{3+4}; veins M_{1+2} beyond R_5, M_1 and M_2, and R_4 absent, or weakly indicated as color lines; cells R_5 and 1st M_2 thus not delimited; M_2 and m indicated as a color line.

Female: Unknown.

Genotype: Protophotopsis scudderi, sp. n.

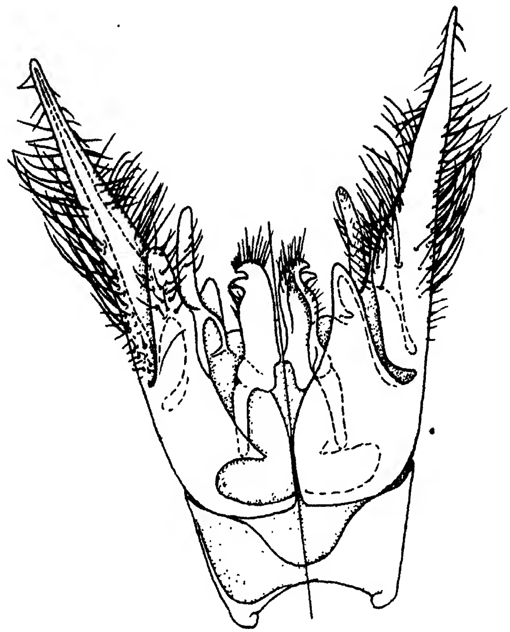
Protophotopsis scudderi, sp. n.

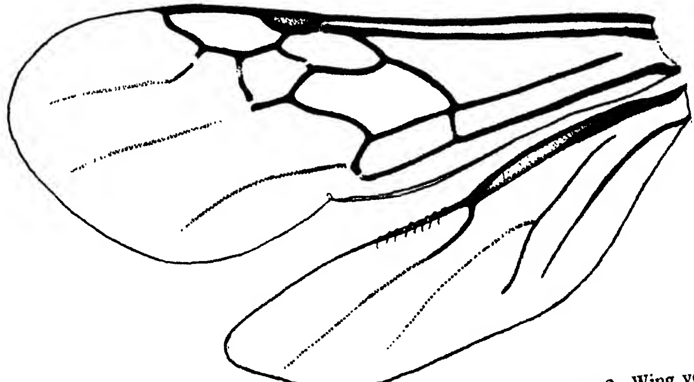
Male: Length 6.2 mm. Entirely black, with moderate, rather sparse evenly distributed erect silvery pubescence (except that of the notum of the thorax, and vertex of the head, and the apical tergites in large part infuscated); body evenly, densely, scarcely coarsely punctured.

Head subquadrate-rounded, its width slightly less than width of thorax at tegulae, well-developed behind eyes, closely, in part subconfluently punctured, rounded behind, the gula and genae and posterolateral angles not carinate. Mandibles and clypeus as in generic diagnosis, the latter distinctly punctured. Antenna short, none of the segments, except the scape and apical segment, more than a fourth longer than wide, the pedicel and first flagellar segments subequal, short, transverse; scape strongly, acutely, longitudinally carinate beneath, the rest of its surface densely hirsute and punctate. The eyes subovate, about a tenth longer than high, distinctly facetted, moderately large, quite convex. Ocelli very small, scarcely evident.

Thorax black, with rounded humeral angles, the pronotum rounded

Mutillidae
R. M. Schuster





Protophotopsis scudderi. Fig. 1. Genitalia of paratype. Fig. 2. Wing venation (color lines indicated by dotted lines; heavily pigmented areas stippled).

into the side pieces, coarsely, closely punctured. Humeral epaulets distinct, a similar tuft of fine hairs on the side pieces of the pronotum on each side, near its posterior margins. Mesonotum convex, closely punctate, lacking parapsidal furrows; the swollen mesopleura evenly convex, lacking an oblique sulcus (i.e., not divided into dorso-anterior and ventro-posterior halves). Tegulae scale-like, small, evenly convex, polished on disk, the edges hirsute and punctate. Scutellum somewhat swollen medially, hardly gibbous, with large punctures (similar in size to those of mesonotum) on the central area, separated by polished intervals; the lateral areas on each side depressed, with some fine silvery pubescence. Metanotum medially nearly continuous with both scutellum and propodeum, and there with some coarse punctures separated by polished intervals; laterally depressed, very closely punctulate, with dense silvery appressed, fine hairs. Metapleura coarsely and irregularly punctured below, glabrous above and channeled, ending in a deep pit-like depression. Propodeum evenly rounded, closely, coarsely, but rather shallowly punctate, locally nearly reticulate, the punctures coarser than those of thorax; dorso-medially also with some scattered punctulations, bearing sparse silvery, decumbent hairs. Legs black, partly dark mahogany or dark piceous, with moderate silvery pubescence and white calcaria. Wings weakly infuscated, with dark brown veins and stigma, the venation as in the generic diagnosis.

Abdomen closely punctured, the apical sternites (except hypopygium) noticeably less coarsely so. Petiole as in generic diagnosis, ventrally coarsely, rather closely punctured, convex, anteriorly strongly laterally compressed and thus produced as a subdentiform, anteriorly directed, punctate ridge; not at all carinate ventrally. Tergites 1–5 and sternites 2–5 each with a distinct row of decumbent, apically twisted or bent setae, in addition to the sparse erect pubescence. Second tergite and sternite with silvery felt-lines, those of the sternites scarcely one-third the length of the segment, situated opposite the posterior half of those of the second tergite; thus not much over half as long as the latter. Second sternite not at all flattened, distinctly convex. Apical tergites closely, coarsely punctured, including the strongly convex last tergite, which has a narrow lateral and posterior margin that is nearly reflexed. Hypopygium coarsely, rather sparsely punctured, flat, the truncate anterior margin nearly impunctate and polished, however; basally, medially strongly depressed to form a transverse pit-like area at its juncture with the seventh sternite.

Genitalia: Parameres thick, cylindrical-tapering, heavy at base; basal section with long, strong setose hairs on the outer-lower face, the inner edges with much finer, but still rather long, equally dense vestiture. Aedeagus rather slender, at apex with two strong, sharp teeth, downward turned; at base ending in long slender falcate apodemes. Digitus volsellaris finger-like, cylindrical, about two-thirds longer than the short, more or less conical lobe-like cuspis volsellaris; the digitus not more than two-fifths the length of the parameres, however. Dorsal parameral plate ending in an obliquely truncate apical lobe on each side.

Holotype: Fedor, Lee Co., Texas, May 29, 1902 (Birkman), in the collection of the Museum of Comparative Zoology. Two paratopotypes, with the same data, one in the collection of the Museum of Comparative

Zoology, one in the author's collection. One paratype, Regnier, Colorado, June 6–8, 1919 (about 37 degrees north, 102 degrees, 50 seconds west, and 4500 feet altitude), in the collection of the American Museum of Natural History; one paratype, Cotulla, Texas, April 5, 1906 (F. C. Pratt), in collection of United States National Museum.

The genitalia ally this genus with the Pseudomethocine wasps in some ways, as can be seen by referring to the figures given by Mickel (Proc. U. S. Nat. Mus., 64: (Art. 15), pls. 1–4, 1924) but in the present genus the aedeagus appears to be better developed, the digitus (sagitta) is comparatively better developed, compared with the cuspis (volsella), nor are the two ever fused at base, as the drawings of Mickel indicate to be the case in *Pseudomethoca*. The general facies of the genitalia, as well as the similarity in shape of the cuspis volsellaris and the parameres indicates that this genus is perhaps allied to the primitive species of *Pseudomethoca*. *Sphaerophthalma* and its allies, can at once be told from both these genera by the fact that the cuspis is always distinctly longer than the digitus, and by the primitively slenderer parameres.

RELATIONSHIP WITH OTHER GENERA

The genus *Protophotopsis* combines a number of primitive characteristics, occurring in both *Sphaerophthalma* and its allied supraspecific groups, on one hand, and in *Pseudomethoca*, *Lomachaeta*, and *Dasymutilla*, on the other hand. The small ocelli, short flagellum, lack of plumose hairs, general structure of the genitalia suggest a distinct relationship with the latter group of genera. The total absence of any ventral mandibular excision or tooth, which is certainly to be interpreted as a secondary condition, allies it to our other diurnal Mutillid genera, except *Lomachaeta*, which in the ventral emargination of the mandibles occupies a very isolated position, as regards the Dasymutilline-Pseudomethocine complex of genera; the total absence of parapsidal furrows also allies *Protophotopsis* to the diurnal complex of genera. From all of these it differs strikingly in the well-developed felt lines of the second abdominal sternite, which ally it to the Sphaerophthalmine wasps. We are dealing here, however, with possibly isolated retention of a very primitive characteristic—the ventral felt lines—while there has been much divergence in other characters. The form of the petiole, the sculpture, the erect vestiture, mostly silvery and sparse, all give the genus a distinct resemblance to the Sphaerophthalmines—at least to the more primitive forms with close sculpture that lack plumose hairs and have very short, incomplete parapsidal furrows.

It is thus apparent that we are dealing with a relict genus here, that has independently retained the felt lines of the second sternite—a characteristic it shares only with the Sphaerophthalmines, with *Pseudophotopsis*, and with a very few other of the genera with small tegulae and round or oval, non-emarginate eyes. The fact that a single species is known, and that the genus will certainly consist of no more than a very few species, when fully known, also indicates that we are dealing with a relict, isolated generic type, evidently not very successful and apparently not very able to compete with other groups today.

The possession of ventral felt lines places the genus in a position somewhat near the base of the Dasymutilline-Pseudomethocine develop-

mental lines, as well as somewhat near the Sphaerophthalmine line of development. The fact that in its lack of specialization towards a nocturnal condition *Protophotopsis* is more generalized than the Sphaerophthalmines has been the cause for selecting the present name. At the same time a direct ancestral relationship to the Sphaerophthalmines is not implied: the writer simply wishes to indicate that in many of its characters the new generic type lies close to the ancestral type of *Sphaerophthalma* and *Photopsis* and the rest of that complex. In the loss of all trace of a ventral mandibular excision *Protophotopsis* must certainly be regarded as more specialized than the Sphaerophthalmines.

Protophotopsis differs from all of the North American genera in the possession of distinct, hyaline, colorless curled setae, occurring in regular rows, one per abdominal segment. The setae are very similar to those found in some *Tiphiidae* (*Paratiphia*) and to those occurring in *Rhopalomutilla* (or at least some species of that genus). In the possession of subapical rows of setae of the abdominal tergites and sternites the present genus agrees with *Lomachaeta* Mickel. It differs from *Lomachaeta* entirely in the nature of these setae, as well as in other significant characters.

Mickel, in his original diagnosis of *Lomachaeta* (Annals Ent. Soc. Amer., Vol. 29, p. 289, 1936) says that this genus is "related to *Dasymutilla* and *Pseudomethoca*"; examination of two males and a single female, kindly loaned by Dr. Mickel, also brings out the fact that there is some relationship to the Sphaerophthalmines, though less close. The original generic diagnosis of *Lomachaeta* only brings out the following differences from *Protophotopsis: Lomachaeta* has the mandibles emarginate below, *Protophotopsis* has them entire; eyes subovate in *Lomachaeta,* nearly circular in *Protophotopsis;* felt lines of second sternite absent in *Lomachaeta*, well-developed in *Protophotopsis;* stigma of fore-wings of *Lomachaeta* much reduced, well-developed in *Protophotopsis.*

In view of the brevity of the original diagnosis of *Lomachaeta*, it thus seems worth-while to indicate what additional differences there exist between the two genera, which are not at all closely related, and to stress certain other generic characters of *Lomachaeta* not brought out in the original description.

The female of *Lomachaeta* is strikingly different from other related genera in that the head is nearly globose; the very coarse sculpture and reticulation of the dorsum of the head and thorax are different from all other North American forms except that those of certain Sphaerophthalmines; the shape of the petiole also is quite similar to that found in some Sphaerophthalmine males and females. A somewhat indefinite indication of a suture, immediately anterior to the metathoracic tubercles bearing the spiracles, as seen in the allotype of *L. hicksi*, appears to be primitive, and differentiates it from the Sphaerophthalmines. The shape of the thorax (elongate-obpyriform) is similar to that of some females of *Sphaerophthalma*.

The males examined (paratypes of *L. hicksi* and *coloradensis*) also have the head quite inflated, but dorsoventrally so, the head looming far above the eyes, as seen from a lateral view; seen from above, the head is quite transverse, and the temples are not at all full; the head is extremely short behind the eyes, the length of the vertex behind the

eyes being less than a fourth the length of the prominent eyes. The eyes are very large, oval-hemispherical (much more prominent than in *Protophotopsis*). In *Protophotopsis*, on the other hand, the head is much fuller in the temples, and transverse-rectangular in dorsal outline; the vertex behind the eyes is longer than the length of the eye; the head is not evidently swollen. The sculpture of the head in *Lomachaeta* males varies from rather distant and very coarse to rather close to confluent and very coarse; in both cases the punctures are not sharply defined; in *Protophotopsis* the punctures are small, regularly and evenly distributed, close, and well-defined.

The thorax of both genera agrees in that the parapsidal furrows of the mesonotum are absent; a fact not brought out in the original diagnosis of *Lomachaeta*. Both genera agree with the other, more or less closely related genera in the group (*Photopsis, Sphaerophthalma, Pseudomethoca, Dasymutilla*) in that the anterodorsal margin of the pronotum has a tuft of fine, backward decumbent, silvery hairs, slightly mesad of the humeral angles; these I term the "*epaulets*." The epaulets appear to be of great significance in the taxonomy of the group; the position of similar areas, near the dorso-posterior corners of the side pieces of the prothorax in some groups (notably some species of *Photopsis* and *Dasymutilla*) is significant. The form, number and position of the epaulets separate the North American round-eyed Mutillidae (except Myrmilloides) from the *Pseudophotopsidinae*, which have depressed areas bearing fine hairs near the lower edge of the side-pieces of the prothorax, and from numerous other Old World genera of *Mutillinae*, that lack them.

The petiole of *Protophotopsis* is much more elongate and strongly nodose, by comparison to the shorter, subsessile petiole of *Lomachaeta;* the latter has the petiole small, not strongly convex, and separated by a very slight constriction from the second tergite. The setae occurring at the apices of the abdominal segments of *Protophotopsis* are entirely different in nature from the hairs occurring just basad of them, and do not intergrade with them; they are furthermore hyaline, twisted, apicad-directed, and decurved or curled under at the tips. In *Lomachaeta*, on the other hand, the setae are clearly derived from hairs; they are black, directed mesad, nearly straight except that their insertion is oblique and they are down curved basally, but straight apically; they are much larger on tergites 2–3 than those of *Protophotopsis*, but on the apical tergites and on all the sternites are scarcely distinct in size from the regular hairs, and differ from them only in being decumbent. The regular rows, of both tergite and sternite, of hyaline apical setae, directed backward, of *Protophotopsis* thus cannot be compared to the sparser, opaque, black setae of *Lomachaeta* that decrease in size as one approaches the lateral margins of the tergites, are directed mesad, and form a distinct V medially; the derivation of these setae from regular hairs is perfectly apparent on the ventral segments, and on the apical tergites.

The sculpture of the abdomen of *Lomachaeta*, especially of segments one and two, is very sparse, very coarse, and consists of poorly defined punctures; the abdomen of *Protophotopsis*, like the rest of the body, is closely, regularly, finely punctured.

THE POSITION OF THE GENUS AND ARRANGEMENT OF THE NEW WORLD MUTILLIDAE[1]

The neogaeic Mutillidae may be tentatively arranged as in the following table. This arrangement leaves most of the Old World types out of consideration (unless they have a direct bearing on the classification of our genera). The position of these groups will be more fully treated in a separate contribution, in which the comparative morphology of the genitalia will be discussed.

The above relationship may be outlined as follows, in accordance with the lettering used in the following table:

TABLE A

RELATIONSHIP OF SOME OF THE CHIEF MUTILLID TYPES, AND OF THE NEW WORLD GENERA[2]

- MUTILLIDAE
  - a' ...... *Apterogyninae* ....
    - h' *Apterogynini* .... *Apterogyna*
    - h *Chyphotini* ....
      - i' *Chyphotes*
      - *Typhoctes* ?
  - a PSEUDOPHOTOPSIDINAE
    - b
      - c SPHAEROPHTHALMINAE
        - d'' .... *Anommutilla*
        - —d
          - e .... Sphaerophthalmine complex—*Sphaerophthalma*
          - e' .... *Protophotopsis*
          - e'' .... Pseudomethocine complex.
            - *Pseudomethoca*
            - *Myrmilloides*
            - *Hoplomutilla*
            - *Pappognatha*
            - *Hoplocrates*
            - etc.
          - e''' .... Dasymutilline complex.....
            - *Dasymutilla*
            - *Traumatomutilla*
          - ... e'''' .... *Lomachaeta*
        - d' ...?...... *Rhopalomutilla* (position doubtful)
      - c' ...... MUTILLINAE
        - f
        - f' *Ephutomma*
          - g *Timulla* (and the entire Timulline-Smicromyrmine-Mutilline complex with sessile petioles and large tegulae and emarginate facetted eyes).
          - g' *Ephuta*

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[1]There has been no general attempt at a classification of the Mutillidae since the disastrous attempt by Ashmead (1903-1904) and the scarcely more satisfactory arrangement by Andre (1903), excepting only the regional classifications of Bradley (1916) and Bischoff (1920). Since there is no accepted classification of the

Mutillidae.—Primitively with felt lines of both second tergite and sternite; mandibles primitively ventrally excised; tegulae primitively small, subcircular, impunctate, not reaching beyond mesonotum; parapsidal furrows primitively absent or incomplete; tarsal claws primitively armed with a tooth within; anal lobe of hind wings primitively present. Female primitively wingless, with the pro-mesothoracic suture distinct, and with distinct ocelli; tarsal claws armed.

a. Petiole formed by both tergite and sternite, the tergite extending to base of segment; ocelli of female retained; pro-mesothoracic suture of female retained; anal lobe of male retained; aculeus of hypopygium not present in male; long felt lines of both tergite and sternite retained, at least in male; male with extensive depressed, densely felted area at lower angles of side-pieces of thorax. (*Male retains tooth on inner side of tarsal claw*),
Pseudophotopsidinae (including only **Pseudophotopsis**)

b. Tooth of tarsal claws lost in male; anal lobe of male hind-wings lost; extensive felt-like area (epaulets) of lower angle of side pieces of male prothorax lost (or never developed).

c. Petiole remains primitively slender, petiolate; eyes with emargination not developed as a sharp notch (except for *Rhopalomutilla*, which may belong elsewhere); tegulae never becoming large and conchiform, remaining rounded and small; eyes usually losing strongly developed facettation,
Sphaerophthalminae

d. Eyes totally losing any indication of a notch of inner orbits; middle tibiae retain two calcaria; antennal tubercles retained; felt lines not totally lost.

e. Felt lines of sternite two of abdomen primitively retained; petiole except secondarily) remains more or less nodose; antennal scrobes develop a small tooth or tubercle in male; parapsidal furrows more or less distinct; plumose hairs generally developed; largely nocturnal; ventral mandibular excision retained,
Sphaerophthalmine complex (**Sphaerophthalma**)

e'. Felt lines of sternite two retained; parapsidal furrows absent; hyaline curled setae developed on abdomen; petiole remains nodose; ventral mandibular excision lost; no scrobal tooth; diurnal; antennae short, first flagellar transverse.........**Protophotopsis** n. g.

e''. Felt lines of sternite two lost; petiole becomes sessile; parapsidal furrows absent (generally); mandibular excision lost; antennal scrobes carinate but not toothed, occasionally not carinate; no special vestiture developed on abdomen (but with tendency to develop spatulate hairs); head usually large and quadrate, with well-developed tendency to develop gular and hypostomal processes; antennae not with first flagellar transverse, short,
Pseudomethocine complex.
(**Pseudomethoca, Myrmilloides, Hoplocrates, Pappognatha, Hoplomutilla, Tilluma, Attilum, Euspinolia,** etc.).

e'''. Felt lines of second sternite lost; petiole remains slender, more or less petiolate; parapsidal furrows absent; mandicular excision lost; antennal scrobes of male not defined above; never with special

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family the following is proposed as a tentative arrangement, for the criticism of the co-workers on the group. The use of the presence of an inner tooth of the tarsal claws, or its absence, the nature of the epaulets, or their absence, and several other characters represent innovations; these have thrown further light on relationships within the group, which, together with the accumulated perspective of the last generation make a new attempt at a classification of some value. More emphasis on the nature and development of the felt lines, the ventral mandibular tooth, the tegula size, development of anal lobes of the wings, and the eye-shape also result in an entirely different arrangement than heretofore given.

[a]This table utilizes a number of new concepts in the relationships existing within the family; these concepts will be discussed at greater length and in more detail in a separate forthcoming paper.

vestiture anywhere; head not becoming large and quadrate, no tendency for ventral processes or carinae; antennae with first flagellar not transverse,
Dasymutilline complex, (**Dasymutilla, Traumatomutilla**)

e''''. Felt lines of second sternite lost; petiole remains slender, petiolate; parapsidal furrows absent; mandibular excision retained; antennal scrobes not defined above; with development of unique abdominal stiff bristles; head not becoming large, more or less globose; no tendency for ventral processes or carinae; first flagellar segment like pedicel, transverse............................**Lomachaeta**

d'. Eyes develop a deep notch, but petiole stays slender, nodose in male; tegulae small; felt lines totally lost in both sexes; antennal tubercles normal; middle tibiae retain two calcars (Exotic),
Rhopalomutilla (position doubtful)

d''. Eyes reniform-oval, as is *Pseudophotopsis*, shallowly and broadly emarginate on inner orbits; antennal tubercles become obsolete; one calcar of middle tibiae lost; felt lines of second sternite lost; petiole slender; tegulae small,
Anommutilla (position doubtful, perhaps belonging in separate family)

c'. Tegulae becoming large, more or less conchiform or expanded, often with slightly revolute edges, reaching to or beyond apex of mesonotum; petiole becoming broad and sessile, transverse; eyes always with strong facettation, ovate or reniform, sharply notched within..**Mutillinae** (s. str.)[3]

(f. Petiole slender, nodose; felt lines entirely lost; tegulae small; female loses all trace of ocelli and dorsal sutures of thorax; felt lines lost,
Rhopalomutilla (position doubtful, in all probability in or near *Sphaerophthalminae*).

f'. Petiole stout, broad, strongly dilated (in the single isolated genus *Ephuta* secondarily becoming small, but there cylindrical and not nodose); felt lines of both tergite and sternite retained; tegulae very large; female retains pro-mesothoracic suture and to a lesser degree the metathoracic-propodeal suture) and ocelli; at least second tergite retains some indication of felt lines, in some species of all genera...**Mutillinae**: the archaic genus **Ephutomma** (exotic; ancestral to the following two types).[4]

g. Petiole remains strongly dilated and sessile; felt lines of second sternite primitively retained, those of second tergite unmodified; male with abdominal tergites not longitudinally, medially

[3]The separation into two basic developmental lines, based on tegula size and essential petiole shape, is believed to be fundamental. Correlated with these characters is the nature of the eye, which is always distinctly facetted, more or less ovate to reniform in shape in the Mutillinae. Whether these two developmental lines, each of which includes several tribes, or generic complexes, should be given subfamily rank is very doubtful. The name *Photopsidinae* could be used for the round-eyed complex with small tegulae were it not for the fact that *Photopsis* is not generically distinct from *Sphaerophthalma* as will be shown elsewhere. This matter will be discussed at greater length in a future contribution.

[4]Bischoff (1920, p. 23) indicates that *Ephutomma* possesses an anal lobe in the male sex; he furthermore (p. 95) stresses the existence of exceedingly close relationship between the latter genus and *Pseudophotopsis*, and states: "Es wäre . . . zu erwägen, ob man nicht die Gattung *Ephutomma* besser also Untergattung zu *Pseudophotopsis* stellen würde. . . . " I do not find that there is any such close relationship between the two genera in question. The absence of an inner tooth of the tarsal claws in *Ephutomma*, the absence of any anal lobe in the male of that genus, as well as the large tegulae, more strongly notched eyes, and decidedly more strongly dilated, not subsessile or subpetiolate first abdominal segment indicates that there is no close relationship, except for such as is inherent in both genera as regards retention of many primitive characteristics. How Bischoff arrived at the idea that *Ephutomma* has an anal lobe in the hind wing is inexplicable, unless, indeed, he has mistakenly included a species of *Pseudophotopsis* in *Ephutomma*, and based his key on this; however, he does not mention the existence of an anal lobe in his generic diagnosis of *Ephutomma* (o. c., pp. 146–148).

carinate. (Ocelli and all dorsal thoracic sutures of female lost),
Tribe Mutillini[5]

g'. Petiole becomes subterete, much narrower than second segment, subcylindrical; felt lines lost (except for a retention of a modified felt line, in the form of a pit, in some species, on tergite two); male with abdominal tergites 5–7 at least longitudinally carinate. (Ocelli and all dorsal thoracic sutures of female lost.),
Tribe **Ephutini (Ephuta)**

a'. First tergite reduced, absent anteriorly, the anterior part of the petiole formed by sternite one alone; ocelli of female lost; pro-mesothoracic suture of female retained throughout; anal lobe of male hind wings retained throughout; hypopygium of male always armed with an aculeus; felt lines strongly reduced to a small tuft in both male and female, on second tergite; male in all forms retains a distinct tooth of the inner side of the tarsal claws; epaulets lost; male lacks parapsidal furrows; ventral mandibular excision and tooth never developed (or lost)..............................Subfamily **Apterogyninae**

h. Wing venation not extremely reduced; second abdominal segment not strongly constricted at apex,
Tribe **Chyphotini (Chyphotes)**

h'. Wing venation extremely reduced, limited to basal third of wings; second abdominal segment strongly constricted at apex in both sexes,
Tribe **Apterogynini (Apterogyna,** exotic)

[5]Bischoff (1920, p. 23) recognizes three tribes here, the *Mutillini*, *Trogaspidini*, and *Smicromyrmini*. It is the writer's belief that the extreme abundance of closely allied types in these groups led Bischoff to attempt a separation here simply because the extreme development of this line in Africa made a separation of some sort desirable, purely as a matter of convenience; no such separation is at all warranted, and the tribal characteristics employed by Bischoff are in part not even of generic value, vide Bradley and Bequart, 1923.

THE LONG-HORNED BEETLES OF OHIO (COLEOPTERA: CERAMBYCIDAE), by JOSEF N. KNULL. Ohio Biol. Surv. Bull. 39, vol. 7, No. 4, pp. 133–354, Pls. 1–28. Ohio State University Studies. Columbus, Ohio, 1946. Price, $1.00.

This work should be at the right hand of everyone who is interested in Coleoptera or who has occasion to identify Cerambycidae from Ohio or the surrounding states. It includes keys and descriptions of 262 species falling in 112 genera, of 46 tribes of the 6 subfamilies of North American Cerambycidae. Included are species known to occur in Ohio as well as many that are likely to occur. As a result of the geographical location of Ohio, its utility extends far beyond the bounds of the state. The descriptions are concise and comparative, designed for a maximum of usefulness. The synonymical bibliographies are presented in a somewhat unorthodox manner but the references cited, in general, include those which are most useful in understanding the species. The terminal bibliography will prove helpful to students of the Cerambycides anywhere in North America.

The work is beautifully illustrated and the drawings, from the pen of Mr. Knull himself, are a most valuable and lasting feature of the publication. To those who have had the privilege of seeing the beautifully mounted and meticulously arranged personal collection of Mr. Knull, this should come as no surprise. His collection reveals the fact that he is an artist! The illustrations include 118 drawings and 2 plates of photographs. The drawings in a few cases involve anatomical details but mostly represent the whole insect. The author has so well caught the facies peculiar to the various species that the specialist can readily recognize them without reference to the explanation of plates. The publication will be useful not only to advanced students of the Cerambycidae but should be an invaluable asset to beginners and to those unfamiliar with the family.

—E. G. LINSLEY.

THE GENERIC AND SUBGENERIC NAMES OF JAPYGIDAE, WITH THEIR GENOTYPES[1]

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The following list is presumed to be complete through 1945, but since the war has disrupted the distribution of scientific journals and the preparation of bibliographic periodicals, its completeness for the most recent literature may be questioned. The list comprises 21 names. In all cases the genotype species has been fixed in connection with the original publication of the name and, except for eight names, the original description of the genotype appears with the generic description.

Dr. Peter Wygodzinsky has been good enough to check this list, but any mistakes or errors are entirely the author's fault.

ALLURJAPYX Silvestri
    Mem. Soc. Ent. Ital., vol. 9 (1930), p. 8.
    Type: *Allurjapyx aethiopicus* Silvestri.

BURMJAPYX Silvestri.
    Rec. Indian Mus., vol. 32 (1930), p. 483.
    Type: *Japyx oudemansi* Parona.

CATAJAPYX Silvestri.
    Boll. Lab. Zool. Portici, vol. 27 (1932), p. 95.
    Type: *Japyx confusus* Silvestri.

DINJAPYX Silvestri.
    Bollettino del Laboratorio di Zoologia Generale e Agraris, Portici, vol. 23 (1930), p. 232.
    Type: *Dinjapyx barbatus* Silvestri.

ECTASJAPYX Silvestri.
    Memorias de la Real Sociedad Espanola, vol. 15 (1929), p. 233.
    Type: *Ectasjapyx bolivari* Silvestri.

EPIJAPYX Silvestri.
    Boll. Lab. Zool. Portici, vol. 27 (1932), p. 105.
    Type: *Japyx corcyraeus* Verhoeff.

EVALLJAPYX Silvestri.
    Boll. Lab. Zool. Portici, vol. 5 (1910), pp. 75–76.
    Type: *Evalljapyx sonoranus* Silvestri.

HEMIJAPYX Ewing.
    Proc. Ent. Soc. Wash. 43 (1941), p. 69.
    Genotype: *Hemijapyx unidentatus* Ewing.

HETEROJAPYX Verhoeff
    Arch. Naturgesch, vol. 70 (1) (1903), p. 102.
    Type: *Japyx novaezeelandie* Verhoeff.

INDJAPYX Silvestri.
    Rec. Indian Mus., vol. 32 (1930), p. 451.
    Type: *Japyx indicus* Oud.

JAPYGELLUS Silvestri.
    Boll. di Zool. Gen. e Agr., vol. 23 (1929), pp. 194.
    Type: *Japygellus serrifer* Silvestri.

[1]Contribution No. 265 from the Department of Entomology, University of Illinois, Urbana.

JAPYGINUS Silvestri.
Boll. di Zool. Gen. e Agr., vol. 23, (1929), pp. 190–192.
Type: *Japyginus breviforceps* Silvestri.

JAPYX HALIDAY.
Trans. Linn. Soc. Lond., vol. 24 (1864), p. 442.
Type: *Japyx solifugus* Haliday.
Original spelling *Iapyx*.

MEGAJAPYX Verhoeff.
Arch. Naturgesch, vol. 70 (1) (1904), p. 101.
Type: *Japyx gigas* Brauer.

METAJAPYX Silvestri.
Boll. Lab. Zool. Portici, vol. 27 (1933), p. 82.
Type: *Japyx* (*Metajapyx*) *aemulans* Silvestri.
Considered by Silvestri as a subgenus.

MIOJAPYX Ewing.
Proc. Ent. Soc. Wash., 43 (1941): 69–75.
Type: *Miojapyx americanus* Ewing.

MIXOJAPYX Silvestri.
Boll. Lab. Zool. Portici, vol. 27 (1933), pp. 135.
Type: *Japyx saussurei* Humbert.

NEOJAPYX Silvestri.
Boll. Lab. Zool. Portici, vol. 27 (1933), p. 120.
Type: *Neojapyx guianae* Silvestri.

OPISTHJAPYX Silvestri.
Bul. Soc. Ent. France, 1929, p. 245.
Type: *Opisthjapyx seurati* Silvestri.

PARAJAPYX Silvestri.
Ann. Scoul. Agric. Portici, vol. 5 (1903), p. 6.
Type: *Japyx isabellae* Grassi.

PARINDJPAYX Silvestri.
Boll. Lab. Zool. Portici, vol. 27 (1932), p. 97.
Type: *Parindjapyx crivellarii* Silvestri.

BOOK NOTICE

THE INSECT FAUNA, REVISED, by WILLIAM PROCTER. Part VII. Biological Survey of the Mount Desert Region, Inc., founded and directed by William Procter. Map, 566 pp. and illustrations of habitats, 1946. Wistar Institute of Anat. and Biol., Philadelphia. Published for private distribution.

Part I, 1927, of the Biological Survey of the Mount Desert Region was written by C. W. Johnson, dipterist of the Boston Society of Natural History. Johnson and Procter were friends. At the time Procter was fully occupied with lists of marine fauna while Johnson, profiting by the long interest of New England entomologists in the remarkably rich fauna of Mount Desert Island, had at hand enough data to publish a first volume for Procter's Biological Survey. Parts II, III, IV and V were lists of the marine and related beach faunas of the island. Part VI, 1938, was a version by Procter of Part I on Insecta. Part VII is a revision and amplification of Parts I and VI with the addition of 1100 species and biological notes.

Because (1) of the extreme care taken in the exact identification of all species by dependable specialists, (2) of the many years of collecting over the hundred square miles of Mount Desert Island and, (3) because of the remarkable mixture of Arctic, Canadian and Atlantic Coastal plain species this list with many observations on habit, distribution and season on the wing is one of the most useful and valuable regional lists of insects we have. It covers an area much more northerly than the very useful Connecticut lists and one farther northeast than the New York State List. It is of special use to students of the insects of Maine, New Brunswick and Nova Scotia.

As pointed out by Procter in the introduction, the basis of the rich fauna appears to be the richness of the flora. The great specialist on the distribution of floral elements from the Carolinas to Labrador, Professor M. L. Fernald, Harvard Botanist, has written of the island's flora: "This extraordinary accumulation within one small area of the typical plants of the arctic realm, of the Canadian zone and in many cases of the southern costal plain cannot be duplicated at any point known to the writer". For years Mount Desert Island has been a favorite collecting place for New England entomologists. Thus the list is a summary not only of Procter's great collection at the Laboratory of the Survey but of material formerly in the Museum of the Boston Society of Natural History, in the Museum of Comparative Zoology of Harvard, the collections in the Massachusetts' State Agricultural College, Amherst, in the University of Maine at Orono and in several of the lesser New England institutions. The U. S. National Museum specialists have helped particularly on Hymenoptera. It thus becomes one of the most dependable lists of its size.

The richness of the flora and of the consequent insect fauna appears to be due to (1) the geographic location of this island at the juncture of three floral areas as mentioned, (2) the nearly constant level of a fairly high humidity due to the adjacent ocean and the moderate or cool temperatures, and (3) the very equitable temperature where records show a summer high of 78°F. and a winter low of only 5°F.

The leaders in the great eastern biological institutions know William Procter better than do the entomologists. Born into an international business but always interested in biology he has been a most valuable supporter of and advisor to various scientific institutions. He is a Trustee of the American Museum of Natural History, a member of the board of managers of the Wistar Institute and a member of the advisory board of the Department of Zoology of Columbia University. He was educated in biology at Yale, the Sorbonne (Paris), Columbia University and has the degree D. Sc. from the University of Montreal. He has been eminently successful in everything he has touched. He recognizes opportunities in biology as well as in business, and has the ability to develop such by sound plans and leadership. He has supported our Annals generously but better yet by sound advice and friendly letters to the editors has kept them from that despondency that is apparently one of the afflictions involved in editoral misadventures. Annals editors have been very grateful for his stimulating interest. It has lifted editorial work above grinding routine.—C. H. KENNEDY.

ERRATA

Page 191, Fig. 1. The cut is inverted, with the proximal ends of the elytra downward. As it stands the five figures should be numbered 1 to 5 from *right* to *left*.

Page 268, couplet 10. *Ormae* should be spelled *ormea*.

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All new names are printed in *italics*.